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Capelin (*Mallotus villosus*) in the Estuary and Gulf of St. Lawrence (NAFO Divisions 4RST) in 2012

François Grégoire, Linda Girard, Jean-Louis Beaulieu, Jean-Francois Lussier and Benoît Bruneau

Department of Fisheries and Oceans
Maurice-Lamontagne Insitute
850, Route de la Mer
Mont-Joli, Quebec
CANADA G5H 3Z4

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Foreword

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ABSTRACT

In 2012, data on capelin landings in the Estuary and the Gulf of St. Lawrence (NAFO Divisions 4RST) totalled 9,472 t. Most of these landings were made in Division 4R with a total of 8,847 t. Landings were also made in Divisions 4S and 4T with respective tonnages of 478 t and 147 t. The performance index of the purse seine fishery in 4R has increased from 2005 to 2012. Since 2008, this index is higher that the upper limit of the historical average. Capelin is a regular by-catch in the shrimp fishery. In 2012, these by-catches amounted to 149 t. Since 2000, these by-catches varied from 77 t to 322 t. They were more important in the Sept-Îles and Esquiman shrimp fishery areas. Mean lengths of females and males caught in 4R increased between 1999 and 2003 and they have been near the historic average since. The lengths in 4R are similar or slightly higher than in unit area 4Sw. However, these lengths are greater than those of capelin caught in 4Tn. The dispersion index measured for the whole Gulf of St. Lawrence has been on the rise between 1990 and 2003. Relatively stable values were subsequently observed with an increase from 2009 and values that reached historical highs in 2010, 2011, and 2012.

According to all these results and given the key role of capelin as a forage species in the marine ecosystem of the Estuary and Gulf of St. Lawrence, any increase in the 4RST TAC should be made cautiously, less than 10% as a total over the next two years. Fishing effort should also be spread along the coast and not-concentrated locally.

RÉSUMÉ

En 2012, les données de débarquements de capelan de l'estuaire et du golfe du Saint- Laurent (Divisions 4RST de l'OPANO) se sont chiffrées à 9 472 t. La plupart de ces débarquements provenait de la Division 4R avec un total de 8 847 t. Des débarquements ont aussi été réalisés dans les Divisions 4S et 4T avec des tonnages respectifs de 478 t et 147 t. L'indice de performance de la pêche à la senne bourse dans 4R a été à la hausse de 2005 à 2012. Depuis 2008, cet indice est plus élevé que la limite supérieure de la moyenne historique. Le capelan est une prise accessoire régulière de la pêche à la crevette. En 2012, ces prises se sont élevées à 149 t. Depuis 2000, ces prises accessoires ont varié de 77 t à 322 t. Elles ont été plus importantes dans les zones de pêche à la crevette de Sept-Îles et d'Esquiman. Les longueurs moyennes des femelles et des mâles capturés dans 4R ont augmenté entre 1999 et 2003 et elles se maintiennent depuis près de la moyenne historique. Les longueurs sont similaires ou légèrement plus élevées dans 4R que dans la zone unitaire 4Sw. Cependant, ces longueurs sont plus élevées que celles des capelans capturés dans 4Tn. L'indice de dispersion mesuré pour l'ensemble du golfe du Saint-Laurent présente une hausse entre 1990 et 2003. Des valeurs relativement stables ont été observées par la suite avec une hausse à partir de 2009 et des valeurs qui ont atteint des sommets historiques en 2010, 2011 et 2012.

Selon tous ces résultats et compte tenu du rôle de premier ordre du capelan en tant qu'espèce fourragère de l'écosystème marin de l'estuaire et du golfe du Saint-Laurent, toute augmentation du TAC de 4RST devrait se faire prudemment, soit moins de 10 % au total pour les deux prochaines années. L'effort de pêche devrait aussi être dispersé le long de la côte et non concentré localement.

1. INTRODUCTION

1.1 INTEGRATED FISHERY MANAGEMENT PLAN (IFMP)

Commercial exploitation of capelin (*Mallotus villosus*) in the Estuary and Gulf of St. Lawrence (NAFO Divisions 4RST) (Figure 1) is managed using an Integrated Fishery Management Plan (IFMP). The two key objectives of the IFMP are conservation of the resource and long-term performance of the fishery. It acknowledges capelin's role as a forage species and aims to maintain and improve ecosystem health through sound management. Lastly, the IFMP acknowledges that all participants must be involved in the development and enforcement of management rules and in the decision-making process.

On the west coast of Newfoundland (Division 4R), the number of fixed gear licences is 235 (this includes Subdivision 3Pn). There are also 21 mobile gear licences. Of these, 16 are for vessels under 65' (19.81 m) and five for vessels over 65'. On Quebec's North Shore (Division 4S), there are 65 fixed gear and six mobile gear licences. In the Estuary and the southern Gulf of St. Lawrence (Division 4T), there are two fixed gear and six mobile gear licences, two of which are for vessels over 65'.

On the west coast of Newfoundland, dockside monitoring of capelin catches is mandatory for all commercial licence holders. Capelin are landed and weighted in the presence of a person certified in accordance with procedures developed in consultation with the industry and with monitoring companies. On Quebec's North Shore, dockside monitoring is mandatory only if fishers' catches are landed at a port located outside of their home region. In the southern Gulf, dockside monitoring is mandatory for all commercial licence holders. The IFMP also includes management measures for reducing accidental catches of Atlantic salmon (*Salmo salar*) and cod (*Gadus morhua*). Commercial quotas are assigned by NAFO Division and type of gear and are fished competitively or by individual quota (IQ). The share of the Total Allowable Catches (TAC) associated to the entire Divisions 4RST between the various fleets is summarized as follows:

Fleet	Sharing
4R-fixed gears (competitive)	37.82%
4R-mobile gears <65' (IQ)	24.15%
4R-mobile gears >65' (competitive)	24.15%
4ST-all gears (competitive)	13.88%

and quotas (t) between the fishing zones of Division 4R in the following manner:

Division	Gear type	Fishing zones	Quotas (t)
4R	**Fixed**	South of Cape St. Gregory	392
		Cape St. Gregory to Broom Point	392
		Broom Point to Point Riche	544
		Point Riche to Big Brook	1 758
		Big Brook to Cape Bauld	959
		Gulf Shore Labrador	872
	Mobile	West Coast 4R3Pn - <65'	3 139
		West Coast 4R3Pn - >65'	3 139
	TOTAL		11 195

1.2 SCIENCE ROLE IN THE IFMP

Several sectors (Fisheries and Aquaculture Management, Conservation and Protection, Policies, Communications) of the Department of Fisheries and Oceans have an important role in preparing and monitoring the IFMP. The following tasks fall under the Science sector:

- Provide advice on the status of the Estuary and Gulf of St. Lawrence stock.
- Report any concerns regarding conservation.
- Provide advice on management solutions to answer conservation concerns.
- Identify data requirements, as needed, to facilitate adjustments during the season and post-season assessments.

1.3 MAIN OBJECTIVE

A science advisory process took place in February 2013 to provide the Fisheries and Aquaculture Management sector with advice on the status of capelin stock in the Estuary and the Gulf of St. Lawrence (terms of reference are found in Appendix 1). A science advisory report was then published in April 2013 by the Canadian Science Advisory Secretariat (CSAS) (DFO 2013). The analyses that led to the drafting of this report are presented in this document.

2. MATERIAL AND METHODS

2.1 COMMERCIAL LANDINGS

Landings data of the commercial fishery were drawn from the ZIFF (Zonal Interchange File Format) files produced from purchase slips and logbooks. The entry of these data was completed for files prior to the 2012 seasons while that of 2012 will be completed in the coming months.

Landings data were grouped by NAFO division and unit area, as by month, day, fishing gear and length class of fishing vessels. Preliminary landings data for the 2010 season, presented in Grégoire and Bruneau (2011), were revised after the update of the corresponding ZIFF file.

2.2 BY-CATCHES OF THE SHRIMP FISHERY

Data on shrimpers' by-catches in the Estuary and the Gulf of St. Lawrence are gathered annually by at-sea observers. Annual shrimper coverage by observers is about 5%.

The importance of the by-catches in the shrimp fishery was recently the subject of a detailed review (Savard *et al.* 2013). Capelin by-catches from the period 2000 to 2011 have been drawn from this review while those of 2012 were calculated at the time of the availability of the data (January 2013; Savard 2013). Capelin by-catches were grouped by the management area of the shrimp fishery (Annex 2) and NAFO unit area (Figure 1).

2.3 DATA FROM THE MULTIDISCIPLINAIRE GROUNDFISH AND SHRIMP SURVEYS

Capelin is a regular catch in the multidisciplinary groundfish and shrimp (*Pandalus borealis*) surveys in the Estuary and in the northern and southern Gulf of St. Lawrence. Annual capelin abundance distributions (kg/set) were presented for surveys conducted since 1990 and a dispersion index (not an abundance index) was calculated by indicator kriging (Grégoire *et al.* 2002) using presence/absence data. This index represents the mean probabilities of finding capelin in the divisions covered by the surveys.

2.3.1. Variation of the abundance and of the species composition

Annual variations in the abundance and composition of the main fish species (Appendix 3) caught by the Estuary and northern Gulf of St. Lawrence survey were examined using a multivariate approach to describe the possible links between these species and capelin. The abundances (n/set), standardized and transformed (square root), were compared between each pair of consecutive surveys with the ANOSIM procedure of the Primer software (version 6.1.11; Clarke and Gorley 2006) applied on the Bray-Curtis similarity index. The species that have characterized each of these surveys were identified with the SIMPER procedure.

2.4 PERFORMANCE INDEX

Capelin landings on the west coast of Newfoundland are mostly made by a purse seine fishery. This fishery takes place near the coast and every vessel generally makes one fishing trip per day.

A standardized index measuring the performance of this fishery was calculated using a multiplicative model applied to the CPUEs (log(t/day)). The following standardization factors were used: (1) year, from 1986 to 2012; (2) month, where June=6 and July=7; (3) vessels length class : 1=1-34.9' (0.30-10.64 m), 2=35-44.9' (10.67-13.69 m), 3=45-64.9' (13.72-19.78 m), 4=65-99.9' (19.81-30.45 m), 5=100-124.9' (30.48-38.07 m), and 6= >125' (38.10 m); and (4) unit area, i.e. 4Ra, 4Rb, 4Rc and 4Rd. The residuals were examined as the normality and the influence of the data on the model (leverage and Cook's distance). The results are presented in terms of marginal means and standardized indices for selected levels of the model factors (month=6, length code=2 and unit area=4Rc). A multiplicative model was also applied to southern Gulf of St. Lawrence (unit area 4Tn) seiners' CPUEs by testing the significance of the year, month and code lengths for the period 1993-2011.

2.5 COMMERCIAL SAMPLING

The commercial sampling program annually covers key capelin fishing activities in the Estuary and in the Gulf of St. Lawrence. At the main landings sites, this coverage results in taking lengths and in collecting samples (2 capelin/sex/5 mm) that are analyzed in the laboratory. These data allowed to calculate the mean size of the females and males capelin of Division 4R for the 1984-2012 period and for unit areas 4Sw and 4Tn for the 2008-2012 period.

The samples analyzed in the laboratory were also used to calculate the total catches in number and weight as the number of capelin per kilogram. These ratios were compared to a 50 capelin/kg threshold. This threshold is a management tool used to avoid the catches of too many small capelin.

3. RESULTS

3.1 COMMERCIAL LANDINGS

Over the years, most capelin landings in the Estuary and Gulf of St. Lawrence were realized on the west coast of Newfoundland (NAFO Division 4R) (Figure 2). In 2012, they totaled 8,847 t on a total of 9,472 t (Table 1) which represents 79% of the portion of the TAC allocated to Division 4R (11,195 t). Nearly 63% of the west coast of Newfoundland landings or 5,558 t came from unit area 4Rc (Table 2A, Figure 3A). On Quebec's North Shore (Division 4S), 478 t of capelin were landed in 2012 compared to 147 t in the southern Gulf of St. Lawrence (Division 4T) (Table 1). In these two regions, most of the catches were realized in unit areas 4Sw (Quebec's Lower North Shore) (Table 2B, Figure 3B) and 4Tn (Miscou Bank) (Table 2C, Figure 3C).

Most of the capelin catches are made with purse seine (Figure 4). Of the 9,472 t landed in 2012, 6,374 t (67%) came only from this fishing gear compared to 2,287 t (24%) for "Tuck" seine, 684 t (7%) for trap, and finally 127 t (1%) for other seines (Table 3). Most landings in Divisions 4R and 4S are associated with purse seine (Figure 5A) and trap (Figure 5B). Purse seine landings dominate Division 4T since 2006 (Figure 5C). Purse seines replaced weirs, the traditional fishing gear of this division (unit area 4Tp), and pair trawl, which was used during an exploratory fishery in 1998.

Between 1996 and 2000, most purse seine catches were made by vessels of the 35-44.9' and 65-99.9' length classes with the arrival in 2002 of vessels of the 45-64.9' and 100-124.9' length classes (Figure 6A). Since 2003, catches of vessels of the 35-44.9' class have decreased unlike the 45-64.9' class. For the trap fishery, almost all catches are made by vessels under 34.9' (Figure 6B).

The fishery in Division 4R occurs mainly during June and July (Table 4). June 2012 landings were 7,618 t and those of July of 1,229 t compared with respective averages (2000-2011) of 5,222 t and 1,591 t. As in past years, July landings were made only in unit area 4Ra (Table 5). In Division 4S, landings in June and July 2012 were 114 t and 364 t, respectively, compared with averages of 361 t and 315 t (Table 6). In addition, all of them were made in unit area 4Sw (Table 7). Lastly, in Division 4T, all landings were made in June (Table 8) in unit area 4Tn (Table 9).

In Division 4R, the purse seine fishery occurs near the coast and can be concentrated in certain areas only (Figure 7). For example, in 2012, the main fishing activities occurred near Port au Port Bay (4Rc). "Tuck" seine fishery started in 2006 at the northern limit of unit 4Ra and subsequently extend towards the south (Figure 8). In 2012, the main activities of the "Tuck" seine fishery were found in Port-au-Port Bay (4Rc) and along Cap St-Gregory. Since 2006, seiners' catches in Division 4T have come largely from the Miscou Bank (Figure 9). In 2006, capelin catches were also made in Anticosti Island during an exploratory herring fishery.

3.2 PERFORMANCE INDEX

The standardization analysis conducted on CPUEs (log(t/day)) for seiners in Division 4R proved significant ($F=68.42$, $p<0.001$) as did the contribution of each factor in the model ($p<0.01$) (Table 10). The model explains 46% of the total variance. The residuals (Figure 10A) and the standardized residuals (Figure 10B) present no pattern indicating a violation of homogeneity. The data follow a distribution that departs slightly from normality (Figure 10C) and include no

extreme values that could have an impact on the model (all Cook's distances are less than 0.5) (Figure 10D). The performance index of the model, as described by the marginal means, has increased from 2005 to 2011 and has decreased between 2011 and 2012 (Table 11, Figure 11A). Since 2008, the annual values of this index are higher than the upper limits of the 1986-2011 average. The effect on the index is more important for the month of July (Figure 11B), the length classes of large vessels (codes 4, 5 and 6) (Figure 11C) and unit areas 4Rb, 4Rc, and 4Rd (Figure 11D). Table 12 and Figure 12A present the index values in terms of standardized means. The effect of the factors has been set at the following levels: month = 6, code of length = 2, unit area = 4Rc (Figures 12B, 12C, and 12D). This index is from the same model and therefore presents the same pattern that the marginal means. However, the scale of the values of the two indices is different because the marginal means are estimated from the average effect of each factor while standardized means are estimated for predetermined levels of the factors.

The standardization analysis conducted on CPUEs for seiners in area 4Tn also proved to be significant ($F=18.46$, $p<0.001$) as did the vessels length ($p<0.01$) (Table 13). The two other factors of the model, month and year, are not significant ($p>0.05$). The model explains 70% of the total variance and the residuals (Figure 13A) and standardized residuals (Figure 13B) present no patterns suggesting a violation of homogeneity. Most data follow a normal distribution (Figure 13C) and do not include extreme values that could have an impact on the model (all Cook's distances are less than 0.5) (Figure 13D). The performance index described by the marginal means has increased since 2008 but the annual values are not significantly different (Table 11, Figure 14). The effect on the index is more important for the vessel of length class 4 (Figure 14B). The index whose level of factors has been fixed presents the same annual variations (Table 12, Figure 15A) and also a more important effect from length class 4 (Figure 15B).

3.3 SHRIMPERS BY-CATCHES

Shrimpers' total by-catches of capelin were estimated at 149 t in 2012 (Table 14). Over the years, they have ranged between 77.3 t (2001) and 321.7 t (2009). The most important by-catches were realized in the Sept-Îles and Esquiman shrimp fishery areas (Appendix 2).

3.4 COMMERCIAL SAMPLING

In 2012, commercial capelin landings were sampled 10 times in Division 4R and at 3 and 9 times in Divisions 4S and 4T (Table 15). The number of capelin measured was 1,941 for 4R, 486 for 4S, and 1,507 for 4T. The numbers of fish kept for the laboratory analyses are presented in Table 16 and those collected in 2012 will be analyzed in the coming months.

3.5 BIOLOGY

On the west coast of Newfoundland, between 1984 and 1992 average lengths of female and male capelin were above the average of the 1984-2011 period (Figures 16A and 16B). They gradually decreased between 1986 and 1993, and as fishing effort relies on capelin size, the fishery was quickly closed in 1994 and almost completely closed in 1995. The lengths stabilized between 1996 and 1998 before decreasing again in 1999. They increased between 1999 and 2003 and subsequently, they remained stable thereafter near the average. In 2012, mean lengths in 4R were 149 mm for females and 163 mm for males. Over the years, mean capelin

lengths on the east coast of Newfoundland (Divisions 3K and 3L) have presented the same trends as those for capelin on the west coast (Figures 16A and 16B). However, capelin lengths on the east coast were greater in the 1980s. The reduction of the mean lengths would have been caused by a reduction of the age structure. Variations in capelin mean size are also observed in annual length frequencies which, in most of the cases, present only one main mode because of the overlap in sizes among various age groups (Figures 17A and 17B).

The lengths of the females (Figures 18A and 19A) and males (Figures 18B and 19B) capelin caught with seine (purse and "Tuck") are similar or slightly larger in 4R compared to unit area 4Sw. However, these lengths are larger than those of the capelin of unit area 4Tn.

In males (Figure 20A), catches in number are associated with larger tonnage than that in females (Figure 20B) because of the males larger size. This difference also explains why the proportion of females in landings is less than that of males when this proportion is calculated from weights (Figure 21A) and not from numbers (Figure 21B).

Capelin mean numbers per kilogram are generally lower for samples from Divisions 4R and 4S (Figures 22A and 22B) than in Division 4T (Figure 22C). In Division 4R, the 50-capelin-per-kilogram threshold was only exceeded in 1994 and 1995 and between 1999 and 2001 compared to the 1993-1999 period (except 1998) for Division 4S and since 1993 (except 2003) for 4T.

3.6 STATUS OF THE RESOURCE

3.6.1. Capelin catches from the multidisciplinary groundfish and shrimp surveys in the Estuary and the northern Gulf of St. Lawrence and on the Scotian Shelf

The most important capelin catches (kg/set) by the multidisciplinary groundfish and shrimp surveys in the Estuary and the northern Gulf of St. Lawrence are usually made around Anticosti Island and on the west coast of Newfoundland (Figure 23). Since 2008, capelin are also found in importance in the portion of the Estuary located west of Sept-Îles. Catches have been less important in 2012 compared to previous years.

Capelin catches were also made in winter (Appendix 4) and summer (Appendix 5) multidisciplinary surveys conducted on the Scotian Shelf. Most capelin are found in the eastern part of the shelf, where waters are colder.

3.6.2. Capelin catches from the multidisciplinary groundfish survey in the southern Gulf of St. Lawrence

During the 1970s and 1980s, few capelin were caught by the multidisciplinary groundfish survey in the southern Gulf of St. Lawrence. However, the catches have increased during the 1990s and 2000s (Figure 24). The first catches were made off Gaspé, gradually spreading southward in the years that followed. Since 2010, capelin are caught in the majority of the sets.

3.6.3. Probabilities and dispersion index from the multidisciplinary groundfish and shrimp surveys in the Estuary and the northern and southern Gulf of St. Lawrence

Presence/absence data from multidisciplinary surveys conducted in the Estuary and northern and southern Gulf of St. Lawrence were kriged using spherical and exponential variograms

(Table 17). All models presented an adequate adjustment to the data with coefficients of determination greater than 0.88.

The greatest probabilities (80-100%) of catching capelin are generally found in the Estuary and in regions south, west and north of Anticosti Island (Figure 25). Probability maps also show a significant expansion of capelin in the southern Gulf in the 1990s and early 2000s. However, a probability decrease was observed in 2004, 2005 and 2007 in the region between Prince Edward Island, the Magdalen Islands and the west coast of Newfoundland. The probabilities increased again in the southern Gulf as of 2008.

The dispersion index associated with Division 4R presents annual fluctuations but no trend is observed (Table 18, Figure 26A). For Division 4S, an increase in the index was measured between 1990 and 2000 followed by values near the 1990-2011 average (Figure 26B). However, the 2011 and 2012 values are over the upper limit of this mean. An upward trend is measured in the portion of Division 4T covered by the Estuary and northern Gulf survey (Figure 26C). For all of divisions 4RST covered by this survey, an increase is measured between 1990 and 2001, followed by a decrease between 2003 and 2007 (Figure 26D). The index is on the rise since 2009 and the values reached in 2011 and 2012 are above the upper limit of the 1990-2011 average.

For all of Division 4T covered by the southern survey, the dispersion index presents an increase between 1990 and 2003 (Figure 27A). A decrease was observed in 2004 followed by stable values up to 2006. The index has been increasing since 2008, with values above the 1990-2011 average. The values measured in 2011 and 2012 are similar and above the upper limit of the 1990-2011 average.

For all the NAFO Divisions covered by both surveys, the dispersion index shows an increase between 1990 and 2003 (Figure 27B). Relatively stable values are observed then with an increase from 2009 and similar values in 2010, 2011 and 2012.

3.6.4. Variation of the abundance and of the species composition

Significant differences in similarity were measured for the surveys conducted between 1991 and 1995, 1998 and 1999, 2001 and 2003, and since 2009 (Table 19). In terms of species composition and abundance, redfish (*Sebastes* spp.) and Greenland halibut (*Reinhardtius hippoglossoides*), followed by capelin and American plaice (*Hippoglossoides platessoides*) characterize these surveys (Figure 28). The average contribution of redfish is 27.2% but has presented a significant decrease in the early 1990s, unlike that of the Greenland halibut. The mean contribution of this species is 19.4% compared to 12.4% for capelin and 11.8% for American plaice. In 2011 and 2012, the most important contributions are associated with capelin with respective values of 26.1 % and 20.9%.

4. CONCLUSION

4.1 SUMMARY OF THE ASSESSMENT

The main indicators of the fishery and stock status of the Estuary and Gulf of St. Lawrence capelin are the commercial landings, the performance index of the purse seine fishery and the dispersion index. Compared with the 2011 season, the landings decrease of 2012 has

especially been marked in Divisions 4S and 4T. According to the Industry, this decrease of the landings would have been caused by an earlier presence of capelin on the spawning sites (4Tn) or by a spawning that would have occurred offshore and in deep waters (4Sw). These two events have reduced the capelin accessibility to fishing gears. There was a reduction of the performance index in 4R but this decrease was not significant when taking into account the confidence intervals. However, this index has reached historic highs since 2010. The dispersion index for the entire Gulf of St. Lawrence has increased since the beginning of the 1990s to reach in recent years historic highs. However, fluctuations in this index characterize the west coast of Newfoundland.

4.2 RECOMMENDATIONS

It is currently impossible to assess the impact of a large catch increase on (the) capelin population(s) and the rest of the ecosystem because abundance fluctuations are caused primarily by factors other than fishing. As the species' lifespan is short, its abundance can be subject to sudden changes, the population being made up of only a few age groups. Because of the markets, the fishing effort is strongly correlated to the size of female capelin and is concentrated for the regions where environmental conditions are more favourable to growth. Although the commercial fishery may harvest a very small proportion of the total biomass, any TAC increase should be made cautiously due to capelin's prominent role as a forage species in the marine ecosystem.

According to the results of this assessment (two of the stock status indicators are at historic highs and the mean lengths are in the average), any increase in the 4RST TAC should be made cautiously, less than 10% as a total over the next two years. The fishing effort should also be dispersed along the coast, not concentrated locally.

4.3 ABUNDANCE AND ANALYTICAL ASSESSMENT

The indicators of the status of the Estuary and Gulf of St. Lawrence capelin do not represent measures of abundance. For the moment, there is no abundance surveys for the Estuary and the Gulf of St. Lawrence capelin. As a result, it is impossible to use an analytical assessment to calculate biomass, recruitment, mortality caused by the fishery, and a TAC. The TAC currently in force (13,000 t) is not based on quantitative analyses.

4.4 ECOSYSTEMIC ABUNDANCE ASSESSMENT

Capelin is a major forage species in the Estuary and Gulf of St. Lawrence ecosystem. This being the case, declines in the stock could have harmful effects on the productivity of the stocks of its main predators. Any analytical abundance assessment of capelin should include a consumption model by these predators. The ecosystem's requirements defined in this way could serve as the base for establishing a minimum threshold. No fishing should be allowed if abundance levels assessed by an acoustic survey were below this minimum threshold. Conversely, authorized catches should be defined based on a risk analysis measuring the probabilities of reaching certain targets (decreasing, maintaining or increasing the biomass) based on various catch scenarios. This type of ecosystemic abundance assessment is conducted for capelin in the Barents Sea. However, for this stock, all reference points with the exception of B_{lim} remain to be defined.

4.5 SOURCES OF UNCERTAINTIES

The main source of uncertainty is the lack of information on capelin abundance in the Estuary and Gulf of St. Lawrence. There are also significant gaps with regard to the number, location (beaches and deeper water) and size of spawning grounds and the stock structure. In addition, there is very little information on the role that some environmental variables play on annual migration patterns.

4.6 MANAGEMENT CONSIDERATION

The terms of reference presented in Appendix 1 were written jointly by the Fisheries Management and Aquaculture Branch and the Regional Science Branch. The elements included in it were the object of the current assessment. However, one of the initial elements had as an objective the calculation of the capelin abundance in each NAFO Division. This element has been discussed by a working group in December 2012. Considering the nature of the stock (its presence in the entire Gulf of St. Lawrence, its annual migration, etc...), it was concluded that it was not appropriate to evaluate the abundance of a resource for specific areas of its distribution. Therefore, this element was removed from the terms of reference.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

Clarke, K. R., and Gorley, R. N. 2006. PRIMER v6: User manual/tutorial. PRIMER-E, Plymouth, UK, 190 pp.

DFO. 2013. Assessment of the Estuary and Gulf of St. Lawrence (Divisions 4RST) Capelin Stock in 2012. DFO Can. Sci. Advis. Sec., Sci. Advis. Rep. 2013/021.

Grégoire, F., Bourdages, H., et Roy, J. 2002. Production d'un indice de dispersion pour le capelan (*Mallotus villosus*) de l'estuaire et du nord du golfe du Saint-Laurent par le krigeage d'indicatrice. Rapp. Tech. Can. Sci. Halieut. Aquat. 2418: vi + 21 pp.

Grégoire, F., and Bruneau, B. 2011. Capelin *(Mallotus villosus)* in the Estuary and Gulf of St. Lawrence (NAFO Divisions 4RST) in 2010. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2011/023. vi + 116 pp.

Savard, L. 2013. Update of bycatch in the Estuary and Gulf of St. Lawrence Northern shrimp fishery in 2012. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/010 iv+ 27 p.

Savard, L., Gauthier, J., Bourdages, H. and Desgagnés, M. 2013. Bycatch in the Estuary and Gulf of St. Lawrence Northern shrimp fishery. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/151. ii+ 56 p.

TABLES

Table 1. Commercial landings[1,2] (t) and TAC (t) of capelin in NAFO Divisions 4RST since 1960 and 1981 (% of the TAC caught is indicated).

ANNÉE / YEAR	DIVISION				TOTAL	TAC	%
	4R	4S	4T	Inc./ NK[3]			
1960	600	46	32	0	678		
1961	424	50	90	0	564		
1962	514	4	143	0	661		
1963	444	13	94	0	551		
1964	563	33	101	0	697		
1965	755	50	100	0	905		
1966	735	88	43	0	866		
1967	724	39	150	0	913		
1968	734	30	32	0	796		
1969	1 394	92	82	0	1 568		
1970	339	75	42	0	456		
1971	403	15	46	0	464		
1972	370	41	126	0	537		
1973	270	84	75	0	429		
1974	180	113	128	0	421		
1975	68	94	105	0	267		
1976	92	48	336	0	476		
1977	1 514	69	318	0	1 901		
1978	8 341	37	1 323	0	9 701		
1979	5 737	1 132	2 163	0	9 032		
1980	1 939	15	1 566	0	3 520		
1981	2 164	1	237	0	2 402	*25 000*	*10*
1982	156	2	235	0	393	*25 000*	*2*
1983	920	0	104	0	1 024	*25 000*	*4*
1984	1 907	0	180	0	2 087	*25 000*	*8*
1985	2 573	0	545	0	3 118	*25 000*	*12*
1986	3 721	0.01	226	0	3 948	*25 000*	*16*
1987	906	0.1	67	0	973	*25 000*	*4*
1988	4 386	129	248	0	4 763	*25 000*	*19*
1989	5 257	1 078	444	0	6 779	*25 000*	*27*
1990	6 105	164	153	0	6 422	*25 000*	*26*
1991	7 166	59	247	0	7 472	*21 300*	*35*
1992	7 851	856	56	0	8 763	*5 750*	*152*
1993	6 739	1 262	237	0	8 238	*10 750*	*77*
1994	592	208	165	0	966	*11 725*	*8*
1995	15	90	47	0	152	*11 725*	*1*
1996	6 265	461	172	0	6 898	*9 850*	*70*
1997	7 399	252	238	0	7 889	*11 725*	*67*
1998	8 764	141	893	0	9 799	*11 725*	*84*
1999	4 735	10	166	0	4 911	*12 425*	*40*
2000	5 129	0	0	0	5 129	*12 425*	*41*
2001	741	0	0	0	741	*12 425*	*6*
2002	3 295	77	20	0	3 392	*12 425*	*27*
2003	5 032	0	0	0	5 032	*7 455*	*68*
2004	6 975	0	0	0	6 975	*7 455*	*94*
2005	8 522	305	34	0	8 861	*13 000*	*68*
2006	9 326	2 039	518	0	11 883	*13 000*	*91*
2007	6 085	1 344	471	0	7 900	*13 000*	*61*
2008	7 846	2 126	99	0	10 071	*13 000*	*77*
2009	10 147	527	1 405	196	12 276	*13 000*	*94*
2010	8 769	795	1 258	234	11 056	*13 000*	*85*
2011	9 890	974	1 449	0	12 314	*13 000*	*95*
2012[4]	8 847	478	147	0	9 472	*13 000*	*73*
MOYENNE / *AVERAGE*							
1960-1969	689	45	87	0	820		
1970-1979	1 731	171	466	0	2 368		
1980-1989	2 393	122	385	0	2 901		
1990-1999	5 563	350	237	0	6 151		
2000-2009	6 310	642	255	20	7 226		
2010-2011	9 330	885	1 354	117	11 685		

[1] De 1960 a 1978: CIPANO Bulletins Statistiques Vol. 10 a 28; de 1979 a 1984: OPANO Bulletins Statistiques Vol. 29 a 34 / *From 1960 to 1978: ICNAF Statistical Bulletins Vol. 10 to 28; from 1979 to 1984: NAFO Statistical Bulletins Vol. 29 to 34*

[2] Fichiers ZIFF depuis 1985 / *ZIFF files since 1985*

[3] Inconnu / *Not known*

[4] Données préliminaires / Preliminary data

Table 2. Commercial landings (t) of capelin by unit area of NAFO Divisions 4R (A), 4S (B), and 4T (C) since 1985.

(A) ZONE UNITAIRE / *UNIT AREA*	MOYENNE / *AVERAGE*		ANNÉE / *YEAR*												MOYENNE / *AVERAGE*	
	1985-1989	1990-1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*	2000-2009	2010-2011
4Ra	1 163	699	0	0	115	513	3 965	4 946	5 917	5 315	883	2 570	2 409	3 378	1 418	2 422	2 893
4Rb	41	1 261	356	0	856	1 070	765	942	9	6	188	2 929	4 785	507	1 692	712	2 646
4Rc	439	2 812	4 773	605	2 323	3 450	2 185	2 289	2 644	691	2 692	4 116	1 442	4 021	5 558	2 577	2 732
4Rd	52	527	0	136	0	0	61	346	756	73	4 083	531	133	1 985	179	599	1 059
NK**	1 673	264	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3 369	5 563	5 129	741	3 295	5 032	6 975	8 522	9 326	6 085	7 846	10 147	8 769	9 890	8 847		

(B) ZONE UNITAIRE / *UNIT AREA*	MOYENNE / *AVERAGE*		ANNÉE / *YEAR*												MOYENNE / *AVERAGE*	
	1985-1989	1990-1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*	2000-2009	2010-2011
4Si	0	0	0	0	0	0	0	0	66	0	0	0	0	0	0	7	0
4Ss	0	0	0	0	0	0	0	0	149	0	0	0	0	0	0	15	0
4Sv	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4Sw	240	333	0	0	7	0	0	305	1 317	1 344	1 420	527	795	974	478	492	885
4Sx	0	0	0	0	0	0	0	0	507	0	0	0	0	0	0	51	0
4Sy	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4Sz	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NK**	0	0	0	0	70	0	0	0	0	0	706	0	0	0	0	78	0
TOTAL	241	350	0	0	77	0	0	305	2 039	1 344	2 126	527	795	974	478		

(C) ZONE UNITAIRE / *UNIT AREA*	MOYENNE / *AVERAGE*		ANNÉE / *YEAR*												MOYENNE / *AVERAGE*	
	1985-1989	1990-1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*	2000-2009	2010-2011
4Tf	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	12
4Tg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4Tj	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
4Tm	1	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4Tn	44	92	0	0	0	0	0	0	474	430	66	1367	1258	1409	147	234	1 334
4To	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4Tp	253	110	0	0	0	0	0	34	43	41	33	39	0	0	0	19	0
4Tq	1	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
NK**	7	10	0	0	17	0	0	0	0	0	0	0	0	16	0	2	8
TOTAL	306	237	0	0	20	0	0	34	518	471	99	1 405	1 258	1 449	147		

* Préliminaire / *Preliminary* ; ** Non spécifié / *Not known*

Table 3. Commercial landings (t) of capelin by fishing gear in NAFO Divisions 4RST since 1985.

DIVISION ENGIN / *GEAR*	MOYENNE / *AVERAGE*		ANNEE / *YEAR*													MOYENNE / *AVERAGE*	
	1985-1989	1990-1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*	2000-2009	2010-2011
4RST																	
Senne "Tuck" / "Tuck" *seine*	0	0	0	0	0	0	0	182	788	519	967	1 657	1 558	1 271	2 287	411	1 415
Senne bourse / *Purse seine*	2 586	4 872	5 129	741	3 295	4 654	4 639	5 485	7 335	5 097	6 916	7 445	7 197	7 760	6 374	5 074	7 479
Autres sennes / *Other seines* **	88	59	0	0	0	0	188	116	193	133	54	141	0	93	127	82	46
Trappe / *Trap*	960	1 040	1	0	7	379	2 148	3 078	3 567	2 151	2 135	2 837	2 067	3 189	684	1 630	2 628
Fascine / *Weir*	243	91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chalut / *Trawl*	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Divers / *Others*	39	89	0	0	87	0	0	0	0	0	0	196	234	0	0	28	117
TOTAL	3 916	6 151	5 129	741	3 392	5 032	6 975	8 861	11 883	7 900	10 071	12 276	11 056	12 314	9 472	7 226	11 685

* Préliminaire / *Preliminary*; ** Non spécifié / *Not known*

Table 4. Monthly landings (t) of capelin in NAFO Division 4R since 1960.

ANNÉE / YEAR	MOIS / MONTH										TOTAL
	3	4	5	6	7	8	9	10	11	INC[1] / NK[1]	
1960										600	600
1961				298	103	23					424
1962				246	255	13					514
1963				417	27						444
1964				405	116	42					563
1965				374	262	119					755
1966				364	311	60					735
1967				487	222	15					724
1968				388	289	57					734
1969				613	781						1 394
1970			2	139	184	14					339
1971				237	166						403
1972				49	209	112					370
1973				172	79	19					270
1974		43	87	44	6						180
1975				59	9						68
1976				59	33						92
1977			248	1 210	49	7					1 514
1978			394	7 853	93	1					8 341
1979			4 712	1 018	7						5 737
1980			1 389	489	61						1 939
1981	4			1 983	101	76					2 164
1982				47	105			4			156
1983			113	563	179	65					920
1984				1 508	399						1 907
1985				2 386	35	153					2 573
1986				3 646	74	0.5					3 721
1987				865	37	3	2				906
1988				1 659	2 668	59					4 386
1989				5 255	2						5 257
1990				2 141	3 935	30					6 105
1991				5 137	1 868	145	16				7 166
1992				4 936	2 916						7 851
1993				6 686	53						6 739
1994				87	504	1 2					592
1995				0 02	15						15
1996				5 592	673						6 265
1997				5 503	1 896						7 399
1998				7 069	1 695						8 764
1999			5	4 556	174						4 735
2000				4 806	324						5 129
2001				741	0						741
2002				2 918	376						3 295
2003				3 959	1 073						5 032
2004				3 226	3 749						6 975
2005				6 914	1 609						8 522
2006				9 132	194						9 326
2007				1 570	4 515						6 085
2008				7 008	839						7 846
2009				8 143	2 005						10 147
2010				6 834	1 935						8 769
2011				7 420	2 470						9 890
2012 [2]				7 618	1 229						8 847
Moyenne / Average (2000-2011)	**0**	**0**	**0**	**5 222**	**1 591**	**0**	**0**	**0**	**0**	**0**	**6 813**

[1] Le mois n'est pas connu / *Month not known.* [2] *Données préliminaires / Preliminary data*

Table 5. Monthly landings (t) of capelin in the unit areas of NAFO Division 4R since 1985.

ANNÉE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH*										TOTAL
		2	3	4	5	6	7	8	9	10	Autre / *Other*	
1985	4Ra					0.5	16	153				**169**
	4Rb					23	6					**29**
	4Rc					29	4					**32**
	4Rd											**0**
	Autre / *Other*					2 334	10					**2 343**
	Total	**0**	**0**	**0**	**0**	**2 386**	**35**	**153**	**0**	**0**	**0**	**2 573**
1986	4Ra					1 671	24	0.5				**1 696**
	4Rb					11	6					**17**
	4Rc					1 366	44					**1 410**
	4Rd					174						**174**
	Autre / *Other*					424						**424**
	Total	**0**	**0**	**0**	**0**	**3 646**	**74**	**0.5**	**0**	**0**	**0**	**3 721**
1987	4Ra					584	37	3	1			**624**
	4Rb					95			1			**96**
	4Rc					146						**146**
	4Rd					1						**1**
	Autre / *Other*					40						**40**
	Total	**0**	**0**	**0**	**0**	**865**	**37**	**3**	**2**	**0**	**0**	**906**
1988	4Ra					58	1 323	48				**1 429**
	4Rb					8	11					**18**
	4Rc					8	1	11				**20**
	4Rd					3	9					**12**
	Autre / *Other*					1 582	1 326					**2 907**
	Total	**0**	**0**	**0**	**0**	**1 659**	**2 668**	**59**	**0**	**0**	**0**	**4 386**
1989	4Ra					1 897						**1 897**
	4Rb					45	2					**47**
	4Rc					585						**585**
	4Rd					76						**76**
	Autre / *Other*					2 652						**2 652**
	Total	**0**	**0**	**0**	**0**	**5 255**	**2**	**0**	**0**	**0**	**0**	**5 257**
1990	4Ra					5	1 924	30				**1 959**
	4Rb					9	470					**479**
	4Rc					681	244					**925**
	4Rd					102	2					**104**
	Autre / *Other*					1 344	1 295					**2 639**
	Total	**0**	**0**	**0**	**0**	**2 141**	**3 935**	**30**	**0**	**0**	**0**	**6 105**
1991	4Ra						25	130				**154**
	4Rb					57	25					**82**
	4Rc					3 494	1 381	15	16			**4 907**
	4Rd					1 586	438					**2 023**
	Autre / *Other*											**0**
	Total	**0**	**0**	**0**	**0**	**5 137**	**1 868**	**145**	**16**	**0**	**0**	**7 166**

Table 5. (Continued).

ANNEE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH*										TOTAL
		2	3	4	5	6	7	8	9	10	Autre / *Other*	
1992	4Ra					32	1 522					**1 554**
	4Rb					1 431	75					**1 506**
	4Rc					3 376	1 300					**4 675**
	4Rd					97	19					**117**
	Autre / *Other*											**0**
	Total	**0**	**0**	**0**	**0**	**4 936**	**2 916**	**0**	**0**	**0**	**0**	**7 851**
1993	4Ra					59	14					**73**
	4Rb					430	39					**469**
	4Rc					4 264						**4 264**
	4Rd					1 933						**1 933**
	Autre / *Other*											**0**
	Total	**0**	**0**	**0**	**0**	**6 686**	**53**	**0**	**0**	**0**	**0**	**6 739**
1994	4Ra						10					**10**
	4Rb						265					**265**
	4Rc					15	229	1				**245**
	4Rd					72						**72**
	Autre / *Other*											**0**
	Total	**0**	**0**	**0**	**0**	**87**	**504**	**1**	**0**	**0**	**0**	**592**
1995	4Ra						15					**15**
	4Rb											**0**
	4Rc					0.02						**0**
	4Rd											**0**
	Autre / *Other*											**0**
	Total	**0**	**0**	**0**	**0**	**0.02**	**15**	**0**	**0**	**0**	**0**	**15**
1996	4Ra					112	518					**630**
	4Rb					1 686	155					**1 841**
	4Rc					3 364						**3 364**
	4Rd					430						**430**
	Autre / *Other*											**0**
	Total	**0**	**0**	**0**	**0**	**5 592**	**673**	**0**	**0**	**0**	**0**	**6 265**
1997	4Ra						734					**734**
	4Rb					1 379	1 101					**2 480**
	4Rc					4 111	60					**4 171**
	4Rd					14						**14**
	Autre / *Other*											**0**
	Total	**0**	**0**	**0**	**0**	**5 503**	**1 896**	**0**	**0**	**0**	**0**	**7 399**
1998	4Ra					381	1 446					**1 827**
	4Rb					3 575	240					**3 814**
	4Rc					2 541						**2 541**
	4Rd					572	9					**581**
	Autre / *Other*											**0**
	Total	**0**	**0**	**0**	**0**	**7 069**	**1 695**	**0**	**0**	**0**	**0**	**8 764**

Table 5. (Continued).

ANNÉE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH*										TOTAL
		2	3	4	5	6	7	8	9	10	Autre / *Other*	
1999	4Ra						29					29
	4Rb				5	1 525	146					1 675
	4Rc					3 031						3 031
	4Rd											0
	Autre / *Other*											0
	Total	0	0	0	5	4 556	174	0	0	0	0	4 735
2000	4Ra											0
	4Rb					250	106					356
	4Rc					4 556	218					4 773
	4Rd											0
	Autre / *Other*											0
	Total	0	0	0	0	4 806	324	0	0	0	0	5 129
2001	4Ra											0
	4Rb											0
	4Rc					605						605
	4Rd					136						136
	Autre / *Other*											0
	Total	0	0	0	0	741	0	0	0	0	0	741
2002	4Ra						115					115
	4Rb					687	170					856
	4Rc					2 232	92					2 323
	4Rd											0
	Autre / *Other*											0
	Total	0	0	0	0	2 918	376	0	0	0	0	3 295
2003	4Ra						513					513
	4Rb					623	448					1 070
	4Rc					3 337	113					3 450
	4Rd											0
	Autre / *Other*											0
	Total	0	0	0	0	3 959	1 073	0	0	0	0	5 032
2004	4Ra					404	3 560					3 965
	4Rb					576	189					765
	4Rc					2 185						2 185
	4Rd					61						61
	Autre / *Other*											0
	Total	0	0	0	0	3 226	3 749	0	0	0	0	6 975
2005	4Ra					4 129	817					4 946
	4Rb					150	792					942
	4Rc					2 289						2 289
	4Rd					346						346
	Autre / *Other*											0
	Total	0	0	0	0	6 914	1 609	0	0	0	0	8 522

Table 5. (Continued).

ANNÉE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH* 2	3	4	5	6	7	8	9	10	Autre / *Other*	TOTAL
2006	4Ra					5 723	194					5 917
	4Rb					9						9
	4Rc					2 644						2 644
	4Rd					756						756
	Autre / *Other*											0
	Total	0	0	0	0	**9 132**	**194**	0	0	0	0	9 326
2007	4Ra					800	4 515					5 315
	4Rb					6						6
	4Rc					691						691
	4Rd					73						73
	Autre / *Other*											0
	Total	0	0	0	0	**1 570**	**4 515**	0	0	0	0	6 085
2008	4Ra					187	696					883
	4Rb					46	142					188
	4Rc					2 692						2 692
	4Rd					4 083						4 083
	Autre / *Other*											0
	Total	0	0	0	0	**7 008**	**839**	0	0	0	0	7 846
2009	4Ra					566	2 005					2 570
	4Rb					2 929						2 929
	4Rc					4 116						4 116
	4Rd					531						531
	Autre / *Other*											0
	Total	0	0	0	0	**8 143**	**2 005**	0	0	0	0	10 147
2010	4Ra					474	1 935					2 409
	4Rb					4 785						4 785
	4Rc					1 442						1 442
	4Rd					133						133
	Autre / *Other*											0
	Total	0	0	0	0	**6 834**	**1 935**	0	0	0	0	8 769
2011	4Ra					908	2 470					3 378
	4Rb					507						507
	4Rc					4 021						4 021
	4Rd					1 985						1 985
	Autre / *Other*											0
	Total	0	0	0	0	**7 420**	**2 470**	0	0	0	0	9 890
2012*	4Ra					189	1 229					1 418
	4Rb					1 692						1 692
	4Rc					5 558						5 558
	4Rd					179						179
	Autre / *Other*											0
	Total	0	0	0	0	**7 618**	**1 229**	0	0	0	0	8 847

* Préliminaire / *Preliminary*

Table 6. Monthly landings (t) of capelin in NAFO Division 4S since 1960.

ANNÉE / *YEAR*	MOIS / *MONTH*										TOTAL
	3	4	5	6	7	8	9	10	11	INC[1] / *NK*[1]	
1960			28	9	9						46
1961			18	25	6	1					50
1962				4							4
1963			7	6							13
1964			7	2	24						33
1965	1	3	14	25	1		1	2	1	2	50
1966			65	21	1	1					88
1967		3		36							39
1968				26	4						30
1969			13	71	8						92
1970		2	26	47							75
1971			2	13							15
1972			7	34							41
1973			58	26							84
1974			82	28	3						113
1975			56	37	1						94
1976			33	15							48
1977			37	32							69
1978				37							37
1979			1	1 131							1 132
1980				3	12						15
1981			1								1
1982		1	1								2
1983											0
1984											0
1985											0
1986				0.01							0.01
1987		0.1									0.1
1988			5	88	36						129
1989				249	824	5					1 078
1990				22	75	22	22	23			164
1991		1.4	45	5	7	0.6					59
1992			0.5	0.8	845	9					856
1993				8	1 249	6					1 262
1994		0.6	0.03	200	8						208
1995		0.18			86	4					90
1996		2	2	220	196	41					461
1997		2	24	149	77						252
1998			14	3	124	0.05					141
1999				10							10
2000											0
2001											0
2002					7					70	77
2003											0
2004											0
2005				127	178						305
2006				1 857	175	7					2 039
2007				473	870						1 344
2008				1 318	809						2 126
2009				102	426						527
2010				150	645	0.01					795
2011				305	669						974
2012[2]				114	364						478
Moyenne / *Average* (2000-2011)	**0**	**0**	**0**	**361**	**315**	**1**	**0**	**0**	**0**	**6**	**682**

[1] Le mois n'est pas connu / *Month not known*; [2] *Données préliminaires / Preliminary data*

Table 7. Monthly landings (t) of capelin in the unit areas of NAFO Division 4S since 1985.

ANNÉE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH*										TOTAL
		2	3	4	5	6	7	8	9	10	Autre / *Other*	
1985	4Sz											0
	4Sy											0
	4Sv											0
	4Sw											0
	Autre / *Other*											0
	Total	0	0	0	0	0	0	0	0	0	0	0
1986	4Sz					0.01						0.01
	4Sy											0
	4Sv											0
	4Sw											0
	Autre / *Other*											0
	Total	0	0	0	0	0.01	0	0	0	0	0	0.01
1987	4Sz			0.06								0.06
	4Sy											0
	4Sv											0
	4Sw											0
	Autre / *Other*											0
	Total	0	0	0.06	0	0	0	0	0	0	0	0.06
1988	4Sz											0
	4Sy				5							5
	4Sv											0
	4Sw					88	36					124
	Autre / *Other*											0
	Total	0	0	0	5	88	36	0	0	0	0	129
1989	4Sz											0
	4Sy					0.95						0.95
	4Sv					1	1					2
	4Sw					247	823	5				1 075
	Autre / *Other*											0
	Total	0	0	0	0	249	824	5	0	0	0	1 078
1990	4Sz								0.05			0.05
	4Sy											0
	4Sv					1.8	1.8	1.8	1.8	1.8		9
	4Sw					20	73	20	20	22		155
	Autre / *Other*											0
	Total	0	0	0	0	22	75	22	22	23	0	164
1991	4Sz			1.4	45	5						51
	4Sy											0
	4Sv											0
	4Sw						7	0.6				7
	Autre / *Other*											0
	Total	0	0	1.4	45	5	7	0.6	0	0	0	59

Table 7. (Continued).

ANNEE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH* 2	3	4	5	6	7	8	9	10	Autre / *Other*	TOTAL
1992	4Sz				0.5							0.5
	4Sy											0
	4Sv											0
	4Sw					0.8	845	9				855
	Autre / *Other*											0
	Total	**0**	**0**	**0**	**0.5**	**0.8**	**845**	**9**	**0**	**0**	**0**	**856**
1993	4Sz											0
	4Sy											0
	4Sv							0.32				0.32
	4Sw					8	1 249	5				1 262
	Autre / *Other*											0
	Total	**0**	**0**	**0**	**0**	**8**	**1 249**	**6**	**0**	**0**	**0**	**1 262**
1994	4Sz											0
	4Sy			0.42	0.03							0.45
	4Sv						2	0.1				2
	4Sw						197	8				205
	Autre / *Other*											0
	Total	**0**	**0**	**0.42**	**0.03**	**0**	**200**	**8**	**0**	**0**	**0**	**208**
1995	4Sz											0
	4Sy											0
	4Sv											0
	4Sw						86	4				90
	Autre / *Other*			0.18								0.18
	Total	**0**	**0**	**0.18**	**0**	**0**	**86**	**4**	**0**	**0**	**0**	**90**
1996	4Sz			2	2	2		41				46
	4Sy											0
	4Sv											0
	4Sw					219	196					415
	Autre / *Other*											0
	Total	**0**	**0**	**2**	**2**	**220**	**196**	**41**	**0**	**0**	**0**	**461**
1997	4Sz			2	7	7						16
	4Sy				15	15						30
	4Sv											0
	4Sw					125	77					202
	Autre / *Other*				2	2						4
	Total	**0**	**0**	**2**	**24**	**149**	**77**	**0**	**0**	**0**	**0**	**252**
1998	4Sz				14							14
	4Sy											0
	4Sv											0
	4Sw					3	124	0.05				128
	Autre / *Other*											0
	Total	**0**	**0**	**0**	**14**	**3**	**124**	**0.05**	**0**	**0**	**0**	**141**

Table 7. (Continued).

ANNÉE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH*										TOTAL
		2	3	4	5	6	7	8	9	10	Autre / *Other*	
1999	4Sz											0
	4Sy											0
	4Sv											0
	4Sw					10						10
	Autre / *Other*											0
	Total	0	0	0	0	10	0	0	0	0	0	10
2000	4Sz											0
	4Sy											0
	4Sv											0
	4Sw											0
	Autre / *Other*											0
	Total	0	0	0	0	0	0	0	0	0	0	0
2001	4Sz											0
	4Sy											0
	4Sv											0
	4Sw											0
	Autre / *Other*											0
	Total	0	0	0	0	0	0	0	0	0	0	0
2002	4Sz											0
	4Sy											0
	4Sv											0
	4Sw						7					7
	Autre / *Other*										70	70
	Total	0	0	0	0	0	7	0	0	0	70	77
2003	4Sz											0
	4Sy											0
	4Sv											0
	4Sw											0
	Autre / *Other*											0
	Total	0	0	0	0	0	0	0	0	0	0	0
2004	4Sz											0
	4Sy											0
	4Sv											0
	4Sw											0
	Autre / *Other*											0
	Total	0	0	0	0	0	0	0	0	0	0	0
2005	4Sz											0
	4Sy											0
	4Sv											0
	4Sw					127	178					305
	Autre / *Other*											0
	Total	0	0	0	0	127	178	0	0	0	0	305

Table 7. (Continued).

ANNEE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH* 2	3	4	5	6	7	8	9	10	Autre / *Other*	TOTAL
2006	4Sz											0
	4Sy											0
	4Sv											0
	4Sw					1 134	175	7				1 317
	Autre / *Other*					722						722
	Total	0	0	0	0	1 857	175	7	0	0	0	2 039
2007	4Sz											0
	4Sy											0
	4Sv											0
	4Sw					473	870					1 344
	Autre / *Other*											0
	Total	0	0	0	0	473	870	0	0	0	0	1 344
2008	4Sz											0
	4Sy											0
	4Sv											0
	4Sw					945	476					1 420
	Autre / *Other*					373	333					706
	Total	0	0	0	0	1 318	809	0	0	0	0	2 126
2009	4Sz											0
	4Sy											0
	4Sv											0
	4Sw					102	426					527
	Autre / *Other*											0
	Total	0	0	0	0	102	426	0	0	0	0	527
2010	4Sz											0
	4Sy											0
	4Sv											0
	4Sw					155	640	0.01				795
	Autre / *Other*											0
	Total	0	0	0	0	155	640	0.01	0	0	0	795
2011	4Sz											0
	4Sy											0
	4Sv											0
	4Sw					305	669					974
	Autre / *Other*											0
	Total	0	0	0	0	305	669	0.00	0	0	0	974
2012*	4Sz											0
	4Sy											0
	4Sv											0
	4Sw					114	364					478
	Autre / *Other*											0
	Total	0	0	0	0	114	364	0.00	0	0	0	478

* Preliminaire / *Preliminary*

Table 8. Monthly landings (t) of capelin in NAFO Division 4T since 1960.

ANNÉE / YEAR	MOIS / MONTH										TOTAL
	3	4	5	6	7	8	9	10	11	INC[1] / NK[1]	
1960			26	6							32
1961		1	72	16	1						90
1962			130	13							143
1963			86	8							94
1964		4	77	19	1						101
1965								9	6	85	100
1966		1	5	4	6	4	6	9	6	2	43
1967			113	37							150
1968		2	14	13	1		2				32
1969			81	1							82
1970		8	28	6							42
1971		5	33	8							46
1972		2	106	15	1				2		126
1973			56	15	4						75
1974			117	11							128
1975		4	93	8							105
1976	5		228	67	1		24	9		2	336
1977		2	68	245	3						318
1978		32	81	1 209		1					1 323
1979		13	375	1 775							2 163
1980			62	1 428	75	1					1 566
1981		28	173	17	19						237
1982		110	78	40	1			1	5		235
1983		4	79	6	4			11			104
1984			180								180
1985		50	253	241					1.17		545
1986		22	182	22	0.02						226
1987		30	33	3			0.02				67
1988		31	92	110					14.5		248
1989		18	308	118							444
1990	12	17	69	53		0.3	0.2	0.3	0.3		153
1991		10	120	116	1.2						247
1992		2	31	22	0.4						56
1993		2	76	158	0.4						237
1994		1.4	42	108	15						165
1995		5	15	16	11						47
1996		20	69	79	0.1	3	0.4	0.1	0.1		172
1997		61	88	71	18	0.12					238
1998		18	22	701	136	17					893
1999				166							166
2000											0
2001											0
2002		3	7	2		0.01		3		5	20
2003											0
2004											0
2005		4	20	10							34
2006		2	16	501							518
2007		0.3	11	459				0.23			471
2008			1	97						0.39	99
2009		0.5	22	1 376	7						1 405
2010			65	1 193							1 258
2011			0.0	1 449							1 449
2012[2]				147							147
Moyenne / Average (2000-2011)	**0**	**1**	**12**	**424**	**0.6**	**0.001**	**0**	**0.25**	**0**	**0.03**	**438**

[1] Le mois n'est pas connu / *Month not known*

[2] Données préliminaires / *Preliminary data*

Table 9. Monthly landings (t) of capelin in the unit areas of NAFO Division 4T since 1985.

ANNEE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH*										TOTAL
		2	3	4	5	6	7	8	9	10	Autre / *Other*	
1985	4Tm					3						3
	4Tn					219						219
	4Tp			50	251	19				1		321
	4Tq											0
	Autre / *Other*			0.1	2							2
	Total	**0**	**0**	**50**	**253**	**241**	**0**	**0**	**0**	**1**	**0**	545
1986	4Tm				0.6							0.6
	4Tn											0
	4Tp			22	182	22	0.02					226
	4Tq											0
	Autre / *Other*											0
	Total	**0**	**0**	**22**	**182**	**22**	**0.02**	**0**	**0**	**0**	**0**	227
1987	4Tm				0.06							0.06
	4Tn											0
	4Tp			30	33	3			0.02			67
	4Tq											0
	Autre / *Other*											0
	Total	**0**	**0**	**30**	**33**	**3**	**0**	**0**	**0.02**	**0**	**0**	67
1988	4Tm											0
	4Tn											0
	4Tp			31	92	110					15	248
	4Tq					0.05						0.05
	Autre / *Other*											0
	Total	**0**	**0**	**31**	**92**	**110**	**0**	**0**	**0**	**0**	**15**	248
1989	4Tm											0
	4Tn											0
	4Tp			17	270	115						402
	4Tq			0.9	3	3						7
	Autre / *Other*				35							35
	Total	**0**	**0**	**18**	**308**	**118**	**0**	**0**	**0**	**0**	**0**	444
1990	4Tm											0
	4Tn											0
	4Tp		5	15	69	52		0.09	0.05	0.11	0.14	141
	4Tq		8	1.4	0.5	1.1		0.2	0.2	0.2	0.2	11
	Autre / *Other*											0
	Total	**0**	**12**	**17**	**69**	**53**	**0**	**0.3**	**0.2**	**0.3**	**0.3**	153
1991	4Tm					65						65
	4Tn											0
	4Tp			10	97	51	1.2					160
	4Tq				23							23
	Autre / *Other*											0
	Total	**0**	**0**	**10**	**120**	**116**	**1.2**	**0**	**0**	**0**	**0**	247

Table 9. (Continued).

ANNEE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH*										TOTAL
		2	3	4	5	6	7	8	9	10	Autre / *Other*	
1992	4Tm											0
	4Tn											0
	4Tp			2	31	22	0.4					56
	4Tq											0
	Autre / *Other*											0
	Total	**0**	**0**	**2**	**31**	**22**	**0.4**	**0**	**0**	**0**	**0**	**56**
1993	4Tm											0
	4Tn					108						108
	4Tp			2.1	76	49	0.4					128
	4Tq											0
	Autre / *Other*											0
	Total	**0**	**0**	**2.1**	**76**	**158**	**0.4**	**0**	**0**	**0**	**0**	**237**
1994	4Tm					47						47
	4Tn					9	13					22
	4Tp			1.4	42	52	1.3					96
	4Tq			0.01	0.01							0.02
	Autre / *Other*											0
	Total	**0**	**0**	**1.4**	**42**	**108**	**15**	**0**	**0**	**0**	**0**	**165**
1995	4Tm											0
	4Tn											0
	4Tp			1.4	15	16	6					39
	4Tq						5					5
	Autre / *Other*			3								3
	Total	**0**	**0**	**5**	**15**	**16**	**11**	**0**	**0**	**0**	**0**	**47**
1996	4Tm											0
	4Tn				2	2						5
	4Tp			17	61	71	0.1	3.2	0.4	0.1	0.05	152
	4Tq			3	3	3						10
	Autre / *Other*				3	3						5
	Total	**0**	**0**	**20**	**69**	**79**	**0.1**	**3**	**0.4**	**0.1**	**0.05**	**172**
1997	4Tm					7						7
	4Tn				1.1	1.1						2
	4Tp			58	83	57	17	0.12				214
	4Tq			1.6	1.6	1.8						5
	Autre / *Other*			2	3	4	1.1					10
	Total	**0**	**0**	**61**	**88**	**71**	**18**	**0.12**	**0**	**0**	**0**	**238**
1998	4Tm											0
	4Tn					583	119					702
	4Tp			18	22	35	17	17				108
	4Tq					0.16						0.16
	Autre / *Other*					83						83
	Total	**0**	**0**	**18**	**22**	**701**	**136**	**17**	**0**	**0**	**0**	**893**

Table 9. (Continued).

ANNEE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH* 2	3	4	5	6	7	8	9	10	Autre / *Other*	TOTAL
1999	4Tm					70						70
	4Tn					77						77
	4Tp											0
	4Tq											0
	Autre / *Other*					19						19
	Total	0	0	0	0	166	0	0	0	0	0	166
2000	4Tm											0
	4Tn											0
	4Tp											0
	4Tq											0
	Autre / *Other*											0
	Total	0	0	0	0	0	0	0	0	0	0	0
2001	4Tm											0
	4Tn											0
	4Tp											0
	4Tq											0
	Autre / *Other*											0
	Total	0	0	0	0	0	0	0	0	0	0	0
2002	4Tm											0
	4Tn											0
	4Tp											0
	4Tq			3								3
	Autre / *Other*			0.96	7	2		0.01		3	5	17
	Total	0	0	3	7	2	0	0.01	0	3	5	20
2003	4Tm											0
	4Tn											0
	4Tp											0
	4Tq											0
	Autre / *Other*											0
	Total	0	0	0	0	0	0	0	0	0	0	0
2004	4Tm											0
	4Tn											0
	4Tp											0
	4Tq											0
	Autre / *Other*											0
	Total	0	0	0	0	0	0	0	0	0	0	0
2005	4Tm											0
	4Tn											0
	4Tp			4	20	10						34
	4Tq											0
	Autre / *Other*											0
	Total	0	0	4	20	10	0	0	0	0	0	34

Table 9. (Continued).

ANNÉE / *YEAR*	ZONE UNITAIRE / *UNIT AREA*	MOIS / *MONTH*										TOTAL
		2	3	4	5	6	7	8	9	10	Autre / *Other*	
2006	4Tm											0
	4Tn					474						474
	4Tp			2	15	27						43
	4Tq											0
	Autre / *Other*				0.6							0.6
	Total	0	0	2	16	501	0	0	0	0	0	518
2007	4Tm											0
	4Tn					430						430
	4Tp			0.3	11	29				0.2		41
	4Tq											0
	Autre / *Other*											0
	Total	0	0	0.3	11	459	0	0	0	0.2	0	471
2008	4Tm											0
	4Tn					66						66
	4Tp				1	32					0.4	33
	4Tq											0
	Autre / *Other*											0
	Total	0	0	0	1	97	0	0	0	0	0.4	99
2009	4Tm											0
	4Tn					1 367						1 367
	4Tp			0.5	22	10	7					39
	4Tq											0
	Autre / *Other*				0.2	0.04						0.27
	Total	0	0	0.5	22	1 376	7	0	0	0	0	1 405
2010	4Tm											0
	4Tn				65	1193						1 258
	4Tp											0
	4Tq											0
	Autre / *Other*				0.3	0.2						0.5
	Total	0	0	0	65	1 193	0	0	0	0	0	1 258
2011	4Tm											0
	4Tn					1 409						1 409
	4Tp											0
	4Tq											0
	Autre / *Other*				0.02	40						40
	Total	0	0	0.0	0	1 449	0	0	0	0	0	1 449
2012*	4Tm											0
	4Tn					147						147
	4Tp											0
	4Tq											0
	Autre / *Other*											0
	Total	0	0	0	0	147	0	0	0	0	0	147

* Préliminaire / *Preliminary*

Table 10. Results of the multiplicative model used to standardize the capelin catches per unit of effort (performance) (t/day) of the commercial purse seine fishery in NAFO Division 4R, from 1986 to 2012.

Table ANOVA / *ANOVA Table*

	SC / *SS*	dl / *df*	F	Pr(>F)	
Ordonnée / *Intercept*	5745.1	1	12452.634	< 2.200E-16	***
Année / *Year*	156.5	24	14.131	< 2.200E-16	***
Mois / *Month*	2.2	1	4.718	2.994E-02	*
Zone	12.7	3	9.179	4.860E-06	***
Code	689.4	5	298.865	< 2.200E-16	***
Résidus / *Residuals*	1208.8	2620			
Signif.	0 ***	0.001 **	0.01 *	0.05 .	0.1 ' ' 1

Modèle / *Model*: **lpue ~ YEAR + MONTH + ZONE + CODE**

Residus / *Residuals*:	**Min.**	**1Q**	**Médiane / *Median***	**3Q**	**Max.**
	-3.421	-0.357	0.099	0.446	2.164

Coefficients:	**Estimation / *Estimate***	**E.-T. / *Std. Err.***	**t**	**Pr(>|t|)**	
(Ord. / *Int.*)	3.575	0.032	111.591	< 2.000E-16	***
YEAR1	-0.568	0.090	-6.341	2.680E-10	***
YEAR2	-0.422	0.186	-2.273	2.310E-02	*
YEAR3	0.327	0.219	1.494	1.354E-01	
YEAR4	-0.182	0.220	-0.828	4.079E-01	
YEAR5	0.129	0.073	1.754	7.953E-02	.
YEAR6	-0.217	0.053	-4.093	4.380E-05	***
YEAR7	-0.021	0.058	-0.370	7.116E-01	
YEAR8	-0.333	0.155	-2.147	3.192E-02	*
YEAR9	-0.169	0.056	-3.026	2.499E-03	**
YEAR10	-0.184	0.051	-3.582	3.470E-04	***
YEAR11	-0.062	0.054	-1.145	2.522E-01	
YEAR12	-0.219	0.061	-3.573	3.590E-04	***
YEAR13	-0.237	0.059	-4.054	5.190E-05	***
YEAR14	-0.202	0.165	-1.226	2.204E-01	
YEAR15	0.107	0.074	1.461	1.442E-01	
YEAR16	-0.074	0.061	-1.209	2.268E-01	
YEAR17	-0.150	0.060	-2.491	1.281E-02	*
YEAR18	-0.220	0.062	-3.542	4.040E-04	***
YEAR19	0.128	0.064	2.014	4.408E-02	*
YEAR20	0.165	0.078	2.125	3.367E-02	*
YEAR21	0.278	0.073	3.819	1.370E-04	***
YEAR22	0.408	0.072	5.705	1.290E-08	***
YEAR23	0.589	0.079	7.500	8.700E-14	***
YEAR24	0.629	0.078	8.052	1.220E-15	***
MONTH1	-0.052	0.024	-2.172	2.994E-02	*
ZONE_U1	-0.179	0.039	-4.559	5.370E-06	***
ZONE_U2	0.046	0.031	1.493	1.355E-01	
ZONE_U3	0.084	0.024	3.500	4.740E-04	***
CODE1	-0.937	0.068	-13.765	< 2.000E-16	***
CODE2	-0.618	0.028	-22.021	< 2.000E-16	***
CODE3	-0.319	0.034	-9.296	< 2.000E-16	***
CODE4	0.610	0.036	17.103	< 2.000E-16	***
CODE5	0.658	0.039	16.751	< 2.000E-16	***

E.-T. résidus / *Std. Err. residuals*: 0.6792 sur / *on* 2620 dl / *df*

R^2 multiple: 0.4629, R^2 ajusté / *adjusted*: 0.4561

F: 68.42 sur / *on* 33 et / *and* 2620 dl / *df*, p:<2.20E-16

Table 11. *Performance (t/day) and standard error of the purse seine fishery on the west coast of Newfoundland (NAFO Division 4R) and in unit area 4Tn (NAFO Division 4T) measured by a standardized index (marginal means or lsmeans) of the catches per unit of effort.*

ANNÉE / *YEAR*	DIVISION 4R		ZONE UNITAIRE / *UNIT AREA* 4Tn	
	Indice / *Index*	E.-T. / *Std. Err.*	Indice / *Index*	E.-T. / *Std. Err.*
1986	25.37	2.33		
1987	28.93	5.54		
1989	60.69	13.73		
1990	36.51	8.25		
1991	51.00	3.52		
1992	36.11	1.88		
1993	43.92	2.68	9.73	5.55
1994	31.81	4.99	6.82	3.98
1996	37.91	2.25		
1997	37.34	2.08		
1998	42.16	2.52		
1999	36.02	2.43	10.41	6.39
2000	35.38	2.28		
2001	36.16	6.24		
2002	49.89	3.90		
2003	41.66	2.73		
2004	38.60	2.42		
2005	35.98	2.46		
2006	50.95	3.58	51.05	22.56
2007	52.86	4.08		
2008	59.20	4.43	11.14	5.69
2009	67.39	5.20	31.26	11.28
2010	80.70	6.76	47.28	16.19
2011	83.99	6.87	44.63	16.71
2012	73.91	6.00		
1986-2011			**1993-2010**	
Min.:	25.37		**Min.:**	6.82
Moyenne / *Average*:	45.85		**Moyenne / *Average*:**	23.96
Max.:	83.99		**Max.:**	51.05

Table 12. Performance (t/day) and standard error of the purse seine fishery on the west coast of Newfoundland (NAFO Division 4R) and in unit area 4Tn (NAFO Division 4T) measured by a standardized index of the catches per unit of effort. Values of the factors used in the standardization of the models are: month=6, vessel length code=2, and unit area=4Rc.

ANNÉE / *YEAR*	DIVISION 4R		ZONE UNITAIRE / *UNIT AREA* 4Tn**	
	Mois / *Month* =6, Code=2*, 4Rc		Mois / *Month* =6, Code=2*	
	Indice / *Index*	E.-T. / *Std. Err.*	Indice / *Index*	E.-T. / *Std. Err.*
1986	14.10	1.37		
1987	16.09	3.11		
1989	33.78	7.58		
1990	20.31	4.59		
1991	28.36	2.19		
1992	20.09	1.10		
1993	24.44	1.40	12.49	2.29
1994	17.68	2.86	8.75	2.06
1996	21.09	1.20		
1997	20.78	1.04		
1998	23.46	1.28		
1999	20.05	1.23	13.36	4.38
2000	19.69	1.12		
2001	20.13	3.41		
2002	27.76	2.07		
2003	23.18	1.43		
2004	21.47	1.37		
2005	20.02	1.33		
2006	28.35	1.92	46.35	29.93
2007	29.38	2.50		
2008	32.93	2.50	13.11	4.30
2009	37.49	2.83	28.18	17.35
2010	44.89	3.81	42.16	26.09
2011	46.72	3.85	40.14	25.03
2012	41.12	3.23		
1986-2011			**1993-2010**	
Min.:	14.10		Min.:	8.75
Moyenne / *Average*:	25.51		Moyenne / *Average*:	23.49
Max.:	46.72		Max.:	46.35

* Longueur de navire / *Vessel length* = 35 à / *to* 44.9'

** Année et mois non significatifs (p>0,05) / Year and month n*ot significant (p>0.05)*

Table 13. Results of the multiplicative model used to standardize the capelin catches per unit of effort (performance) (t/day) of the commercial purse seine fishery in unit area 4Tn, from 1993 to 2011.

Table ANOVA / *ANOVA Table*

	SC / SS	dl / *df*	F	Pr(>F)	
Ordonnée / *Intercept*	24.112	1	70.753	3.19E-12	***
Année / *Year*	4.163	7	1.745	0.1126	
Mois / *Month*	0.203	1	0.595	0.4433	
Code	12.380	3	12.109	1.79E-06	***
Résidus / *Residuals*	23.855	70			

Signif.	0 ***	0.001 **	0.01 *	0.05 .	0.1 ' '	1

Modèle / *Model*: lpue ~ YEAR + MONTH + CODE

Residus / *Residuals*:	Min.	1Q	Médiane / *Median*	3Q	Max.
	-1.938	-0.147	0.061	0.28043	1.48946

Coefficients:	Estimation / *Estimate*	E.-T. / *Std. Err.*	t	Pr(>|t|)	
(Intercept)	2.965	0.353	8.411	0.000	***
YEAR1	-0.663	0.402	-1.651	0.103	
YEAR2	-1.007	0.422	-2.386	0.020	*
YEAR3	-0.555	0.470	-1.181	0.242	
YEAR4	0.905	0.414	2.187	0.032	*
YEAR5	-0.574	0.328	-1.752	0.084	.
YEAR6	0.375	0.349	1.074	0.286	
YEAR7	0.782	0.357	2.192	0.032	*
MONTH1	-0.234	0.304	-0.771	0.443	
CODE1	-0.167	0.513	-0.326	0.745	
CODE2	-0.334	0.234	-1.432	0.157	
CODE3	0.663	0.190	3.486	0.001	***

E.-T. Résidus / *Std. Err. Residuals*: 0.5838 sur / *on* 70 dl / *df*

R^2 multiple: 0.7436, R^2 ajusté / *adjusted*: 0.7033

F: 18.46 sur / *on* 11 et / *and* 70 dl / *df*, p:2.20E-16

Table 14. Capelin by-catches of the shrimp fishery in the Estuary and Gulf of St. Lawrence, from 2000 to 2012 (See Appendix 2 for the shrimp fishery areas).

ZONE DE PÊCHE À LA CREVETTE (ZPC) / *SHRIMP FISHING AREA (SFA)*	PRISES ACCESSOIRES DE CAPELAN DANS LA PÊCHE À LA CREVETTE (kg) / *CAPELIN BY-CATCHES IN THE SHRIMP FISHERY (kg)*								
	12	10	10	10	10	9	9	9	8
ZONE UNITAIRE DE L'OPANO / *NAFO UNIT AREA*	4Tp 4Tq	4To 4Tn 4Tk	4Tq 4Sz	4Si 4Sy	4Ss	4Tf 4Tk	4Ss	4Sx 4sy 4Sv	4Sv 4Ra 4Rb 4Rc 4R
2000	1 518	5 189	31 798	3 461	28 213	1 784	10 827	12 487	25 586
2001	3 614	3 642	11 407	2 325	8 225	42	2 267	5 716	40 012
2002	537	1 888	12 581	3 472	56 226	490	3 968	25 922	200 852
2003	166	10 283	19 134	1 392	65 348	40	6 044	1 764	31 843
2004	322	2 199	12 121	1 247	137 677	221	9 728	2 541	144 613
2005	2 709	1 097	8 547	15 586	53 059	171	8 451	3 590	125 892
2006	160	5 086	19 975	5 329	17 334	29	3 461	28 797	14 106
2007	969	2 064	9 081	3 162	28 658	5	608	38 255	4 387
2008	917	6 578	9 761	1 230	13 997	2	210	30 450	29 523
2009	2 515	4 183	40 320	4 531	10 971	2	1 287	16 266	241 619
2010	2 101	6 463	15 538	4 855	34 098	0	412	63 368	29 185
2011	1 284	96 943	10 515	16 674	47 747	0	703	26 509	12 078
2012	499	20 279	34 380	8 724	34 657	10	90	26 898	23 735

PRISES ACCESSOIRES DE CAPELAN DANS LA PÊCHE À LA CREVETTE (t) / *CAPELIN BY-CATCHES IN THE SHRIMP FISHERY (t)*				
ZPC / SFA				TOTAL ESTUAIRE ET NORD DU GOLFE / *TOTAL ESTUARY AND NORTHERN GULF*
12	10	9	8	
1.518	68.661	25.098	25.586	120.863
3.614	25.600	8.025	40.012	77.251
0.537	74.168	30.380	200.852	305.938
0.166	96.157	7.848	31.843	136.014
0.322	153.245	12.490	144.613	310.669
2.709	78.289	12.212	125.892	219.101
0.160	47.724	32.288	14.106	94.278
0.969	42.965	38.868	4.387	87.189
0.917	31.567	30.662	29.523	92.669
2.515	60.005	17.555	241.619	321.693
2.101	60.954	63.780	29.185	156.020
1.284	171.880	27.213	12.078	212.455
0.499	98.040	26.998	23.735	149.272

Table 15. Number of samples collected and capelin measured by port samplers in NAFO Divisions 4RST since 1985.

ANNÉE / *YEAR*	DIVISION	FEMELLE / *FEMALE*		MÂLE / *MALE*		TOTAL	
		# ÉCHANTILLONS / *# SAMPLES*	# POISSONS / *# FISH*	# ÉCHANTILLONS / *# SAMPLES*	# POISSONS / *# FISH*	# ÉCHANTILLONS / *# SAMPLES* *	# POISSONS / *# FISH*
1985	4R	7	1 247	7	707	7	1 954
	4S	0	0	0	0	0	0
	4T	1	264	1	111	1	375
1986	4R	12	1 969	12	1 103	12	3 072
	4S	5	361	5	802	5	1 163
	4T	7	180	8	1 897	8	2 077
1987	4R	3	507	3	319	3	826
	4S	3	38	3	702	3	740
	4T	7	176	7	1 590	7	1 766
1988	4R	17	2 404	17	2 067	17	4 471
	4S	9	580	9	1 510	9	2 090
	4T	15	798	17	3 612	17	4 410
1989	4R	10	1 413	10	1 067	10	2 480
	4S	5	250	5	1 075	5	1 325
	4T	6	139	6	1 382	6	1 521
1990	4R	10	1 355	10	1 228	10	2 583
	4S	15	1 281	17	3 190	17	4 471
	4T	28	1 579	28	5 867	28	7 446
1991	4R	7	950	8	1 084	8	2 034
	4S	13	392	14	3 248	14	3 640
	4T	11	771	11	2 055	11	2 826
1992	4R	9	1 238	9	1 064	12	2 302
	4S	12	641	12	2 489	12	3 130
	4T	8	754	10	1 801	10	2 555
1993	4R	12	2 058	12	1 084	12	3 142
	4S	9	706	10	1 912	10	2 618
	4T	5	349	5	904	5	1 253
1994	4R	1	167	1	89	1	256
	4S	7	580	10	2 031	10	2 611
	4T	6	850	7	688	7	1 538
1995	4R	2	24	2	576	2	600
	4S	13	694	15	3 639	15	4 333
	4T	10	1 050	11	1 903	11	2 953
1996	4R	11	1 690	11	1 305	11	2 995
	4S	13	2 325	15	3 870	15	6 195
	4T	12	1 217	15	2 588	15	3 805
1997	4R	10	1 189	10	1 386	10	2 575
	4S	28	1 471	28	5 851	28	7 322
	4T	24	2 249	24	4 184	24	6 433
1998	4R	8	1 067	8	970	8	2 037**
	4S	8	579	8	1 501	8	2 080
	4T	5	966	5	393	5	1 359

Table 15 (Continued).

ANNÉE / *YEAR*	DIVISION	FEMELLE / *FEMALE*		MÂLE / *MALE*		TOTAL	
		# ÉCHANTILLONS / *# SAMPLES*	# POISSONS / *# FISH*	# ÉCHANTILLONS / *# SAMPLES*	# POISSONS / *# FISH*	# ÉCHANTILLONS / *# SAMPLES* *	# POISSONS / *# FISH*
1999	4R	14	2 587	14	1 285	14	3 872***
	4S	2	308	2	207	2	515
	4T	8	1 275	8	937	8	2 212
2000	4R	6	697	6	856	6	1 553****
	4S	0	0	0	0	0	0
	4T	2	31	3	522	3	553
2001	4R	2	289	2	189	2	478
	4S	0	0	0	0	0	0
	4T	0	0	0	0	0	0
2002	4R	7	797	7	1 098	7	1 895
	4S	0	0	0	0	0	0
	4T	0	0	0	0	0	0
2003	4R	5	1 300	5	1 063	5	2 363
	4S	5	157	5	1 020	5	1 177
	4T	12	1 197	12	2 073	12	3 270
2004	4R	8	1 367	8	703	8	2 070
	4S	1	22	6	1 502	6	1 524
	4T	4	173	4	842	4	1 015
2005	4R	7	434	7	619	7	1 053
	4S	6	198	10	1 325	10	1 523
	4T	9	281	9	1 421	9	1 702
2006	4R	10	1 036	10	944	10	1 980
	4S	3	195	3	347	3	542
	4T	3	263	3	605	3	868
2007	4R	7	1 076	7	883	7	1 959
	4S	3	418	3	152	3	570
	4T	4	533	4	448	4	981
2008	4R	7	873	7	487	7	1 360
	4S	4	585	4	185	4	770
	4T	2	270	2	247	2	517
2009	4R	11	1077	11	968	11	2 045
	4S	4	440	4	293	4	733
	4T	5	94	5	725	5	819
2010	4R	6	343	6	689	6	1 032
	4S	8	503	8	814	8	1 317
	4T	12	965	12	2296	12	3 261
2011	4R	4	416	4	306	4	722
	4S	7	492	7	697	7	1 189
	4T	7	548	7	729	7	1 277
2012	4R	10	1098	10	843	10	1 941
	4S	3	348	3	138	3	486
	4T	9	203	9	1304	9	1 507

* Deux fréquences de longueur (femelle et mâle) par échantillon / *Two length frequencies (female and male) by sample*

** Non inclus: un échantillon de 208 capelans de sexe non déterminé / *Not included: one sample of 208 capelin not sexed*

*** Non inclus: un échantillon de 257 capelans de sexe non déterminé / *Not included: one sample of 257 capelin not sexed*

**** Non inclus: un échantillon de 440 capelans de sexe non déterminé / *Not included: one sample of 440 capelin not sexed*

Table 16. Number of capelin collected by port samplers and analysed in the laboratory since 1985.

ANNÉE / *YEAR*	DIVISION	MOIS / *MONTH*					TOTAL
		AVRIL / *APRIL*	MAI / *MAY*	JUIN / *JUNE*	JUILLET / *JULY*	AUTRE / *NOT KNOWN*	
1985	4R		36	199			235
	4S						0
	4T	31					31
1986	4R		11	153			164
	4S		62				62
	4T	43	14	40			97
1987	4R	37		77			114
	4S			24	56		80
	4T	24	51	97			172
1988	4R		20	318	79	95	512
	4S		38	141		9	188
	4T	20	93	232		30	375
1989	4R					200	200
	4S					400	400
	4T					200	200
1990	4R			65	112		177
	4S		54	59	109		222
	4T		158	47			205
1991	4R	16	21	84	8		129
	4S		124	32	17		173
	4T		29	128			157
1992	4R			115	54		169
	4S		12	39	29		80
	4T		63	49			112
1993	4R			150	52		202
	4S			559	68		627
	4T			233			233
1994	4R				17		17
	4S			404	163		567
	4T		56	180			236
1995	4R				62		62
	4S		12	89	63		164
	4T		26	100			126
1996	4R			153	17		170
	4S		38	73	54		165
	4T	27	49	70	24		170
1997	4R			135	34		169
	4S		47	213	76		336
	4T		110	200	29		339
1998	4R			143			143
	4S			62	61		123
	4T		28	24			52

Table 16. (Continued).

ANNÉE / *YEAR*	DIVISION	MOIS / *MONTH*					TOTAL
		AVRIL / *APRIL*	MAI / *MAY*	JUIN / *JUNE*	JUILLET / *JULY*	AUTRE / *NOT KNOWN*	
1999	4R			404			404
	4S			15	21		36
	4T	15	49	35	1		100
2000	4R	500		161			661
	4S						
	4T			21	37		58
2001	4R			54			54
	4S						
	4T						
2002	4R			150	54		204
	4S						
	4T						
2003	4R			156			156
	4S		43	34			77
	4T		49	86			135
2004	4R			119	119		238
	4S			30			30
	4T			95			95
2005	4R			211			211
	4S		32	144			176
	4T		72	136	18		226
2006	4R			302			302
	4S			50			50
	4T		19	64			83
2007	4R			28	190		218
	4S			33	16		49
	4T		61	11			72
2008	4R			6	1		7
	4S			18	1		19
	4T		18	22			40
2009	4R			174	37		211
	4S			35	35		70
	4T		15	51			66
2010	4R			158			158
	4S			34	94		128
	4T			231	12		243
2011	4R			158			158
	4S			43	105		148
	4T		18	240			258
2012	4R	Les données biologiques seront analysées au cours de l'année 2013 / *Biological data will be analysed during the year 2013*					
	4S						
	4T						

Table 17. Parameters of the isotropic variograms for the groundfish and shrimp multidisciplinary surveys conducted in the Estuary, the northern, and the southern Gulf of St. Lawrence, from 1990 to 2012.

ANNÉE / *YEAR*	MODÈLE* / *MODEL**	Pépite / *Nugget* (C_0)	Plateau / *Sill* ($C_0 + C$)	Portée / *Range* (A_0)	R^2	RSS**
1990	Sphérique / *Spherical*	0.013	0.383	664	0.978	2.836E-03
1991	Sphérique / *Spherical*	0.079	0.328	565	0.982	1.306E-03
1992	Sphérique / *Spherical*	0.086	0.322	530	0.992	4.824E-04
1993	Sphérique / *Spherical*	0.109	0.329	572	0.992	2.827E-04
1994	Sphérique / *Spherical*	0.094	0.324	496	0.994	2.200E-04
1995	Sphérique / *Spherical*	0.111	0.319	538	0.988	4.850E-04
1996	Sphérique / *Spherical*	0.099	0.317	480	0.996	1.594E-04
1997	Exponentiel / *Exponential*	0.133	0.291	152	0.952	4.740E-04
1998	Sphérique / *Spherical*	0.092	0.331	545	0.994	2.699E-04
1999	Exponentiel / *Exponential*	0.094	0.284	146	0.930	1.222E-03
2000	Exponentiel / *Exponential*	0.099	0.305	244	0.976	6.135E-04
2001	Exponentiel / *Exponential*	0.087	0.280	130	0.960	5.588E-04
2002	Exponentiel / *Exponential*	0.106	0.248	60	0.948	4.836E-04
2003	Exponentiel / *Exponential*	0.167	0.334	612	0.918	4.014E-04
2004	Sphérique / *Spherical*	0.137	0.308	493	0.998	5.046E-05
2005	Exponentiel / *Exponential*	0.108	0.282	121	0.893	1.864E-03
2005	Sphérique / *Spherical*	0.073	0.262	160	0.880	2.403E-03
2006	Sphérique / *Spherical*	0.136	0.273	317	0.898	1.116E-03
2007	Exponentiel / *Exponential*	0.127	0.255	91.2	0.992	9.412E-05
2008	Exponentiel / *Exponential*	0.043	0.260	59	0.975	1.384E-04
2009	Exponentiel / *Exponential*	0.036	0.255	68	0.980	2.201E-04
2010	Exponentiel / *Exponential*	0.121	0.254	214	0.978	2.300E-04
2011	Exponentiel / *Exponential*	0.076	0.220	98	0.983	1.091E-04
2012	Sphérique / *Spherical*	0.058	0.214	135.8	0.968	9.802E-04

* Modèle sphérique / *Spherical model*

$$\gamma(h)=\begin{cases} C0+C\left[1.5\left(\frac{h}{A_0}\right)-0.5\left(\frac{h}{A_0}\right)^3\right] & \text{if } h\le A_0, \text{ et/and } C0+C \\ \text{autrement / otherwise} \end{cases}$$

Modèle exponentiel / *Exponential model*

$$\gamma(h) = C0 + C\left[1 - \exp\left(-\frac{h}{A_0}\right)\right]$$

** Somme des résiduels au carré / *Residual sum of squares*

Table 18. Capelin dispersion index (%) calculated for the NAFO Divisions covered by the groundfish and shrimp multidisciplinary surveys conducted in the Estuary, the northern, and the southern Gulf of St. Lawrence, from 1990 to 2012.

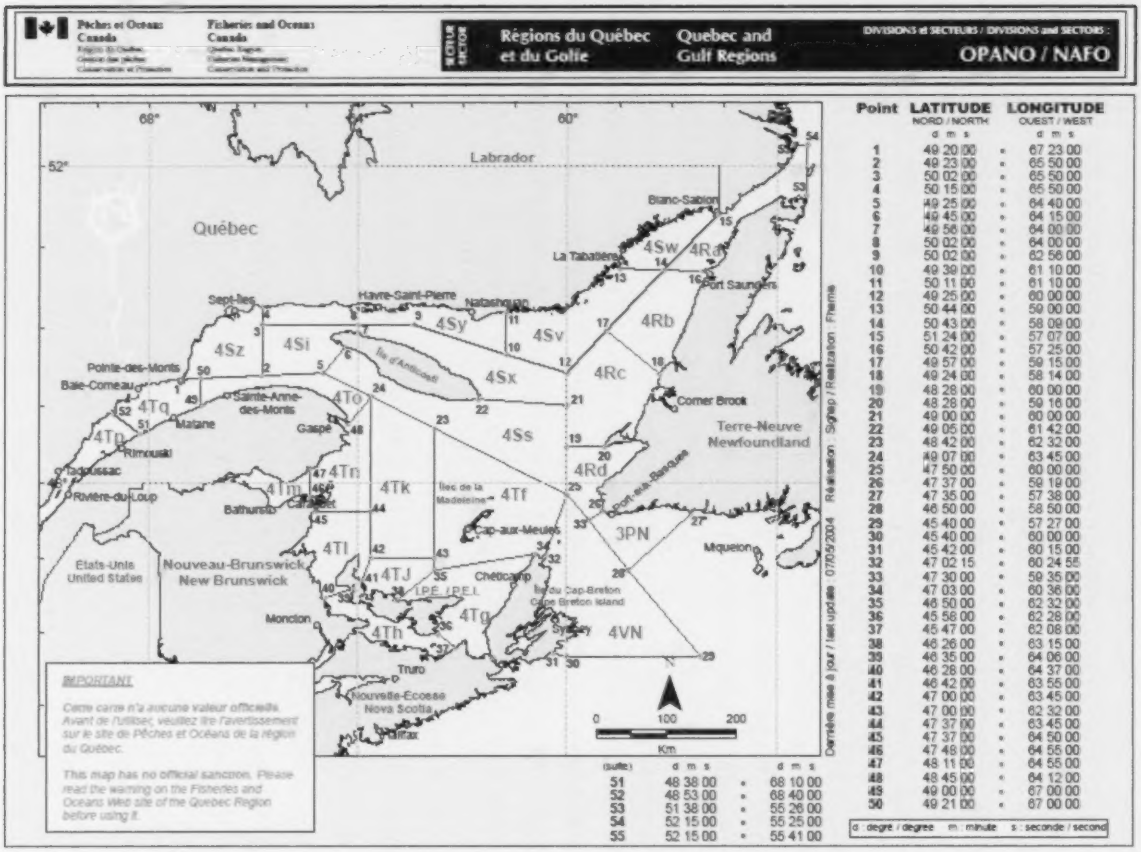
ANNÉE / *YEAR*	RELEVÉS NORD-SUD / *NORTHERN-SOUTHERN SURVEYS*					
	Divisions du relevé nord / *Northern survey divisions*				Division du relevé sud *Southern survey division*	Divisions des relevés nord + sud / *Northern + southern surveys divisions*
	4R	4S	4T	4RST	4T	Golfe 4RST / *Gulf 4RST*
1990	25.83	55.08	48.62	45.81	5.20	30.34
1991	29.39	65.67	54.67	53.62	13.65	38.39
1992	24.51	70.08	59.72	55.58	17.84	41.20
1993	47.49	68.77	73.81	63.81	17.61	46.21
1994	45.16	74.03	60.69	63.60	24.28	48.62
1995	27.68	74.02	64.58	59.48	25.82	46.65
1996	50.20	81.62	76.15	71.93	24.08	53.70
1997	65.31	74.47	49.95	67.44	35.78	55.38
1998	44.74	71.85	67.86	63.62	21.68	47.64
1999	42.92	77.96	79.19	68.49	45.74	59.83
2000	41.83	91.04	86.31	76.57	53.98	67.97
2001	60.05	82.39	76.12	75.06	37.65	60.81
2002	40.66	75.72	76.11	66.09	57.13	62.68
2003	62.73	76.44	92.64	75.63	57.39	68.69
2004	46.64	78.66	80.07	70.07	39.46	58.43
2005	34.99	78.50	73.57	65.57	40.87	56.18
2006	22.61	74.94	75.35	60.56	39.85	52.68
2007	31.85	73.40	77.59	62.69	50.07	57.89
2008	53.14	80.28	65.58	70.08	40.16	58.70
2009	40.98	71.72	73.33	63.52	51.06	58.78
2010	50.54	78.38	83.36	71.60	67.23	69.94
2011	62.00	91.60	90.70	83.30	59.30	74.10
2012	52.60	93.60	82.10	80.10	58.30	71.80
1990-2011						
Min.:	22.61	55.08	48.62	45.81	5.20	30.34
Moyenne / Average:	43.24	75.75	72.09	66.10	37.54	55.22
Max.:	65.31	91.60	92.64	83.30	67.23	74.10

Table 19. *Results of the ANOSIM similarity analyses testing the null hypothesis that there are no differences (significance threshold fixed at 5%) in the abundances (nb/tow) by species from the multidisciplinary groundfish and shrimp surveys conducted in the Estuary and northern Gulf of St. Lawrence, from 1990 to 2012 (the R statistic is calculated for each pair of surveys).*

Survey	R	P (%)
1990-1991	0.012	6.0
1991-1992	0.009	1.5*
1992-1993	0.035	0.1*
1993-1994	0.018	0.3*
1994-1995	0.012	1.9*
1995-1996	0.008	7.4
1996-1997	-0.003	66.4
1997-1998	0.002	26.9
1998-1999	0.011	1.8*
1999-2000	0.007	5.6
2000-2001	0.006	8.9
2001-2002	0.013	1.9*
2002-2003	0.021	0.1*
2003-2004	0.006	21.1
2004-2005	-0.010	92.0
2005-2006	-0.003	72.4
2006-2007	-0.003	75.4
2007-2008	0.003	17.3
2008-2009	0.006	10.2
2009-2010	0.012	3.8*
2010-2011	0.017	0.7*
2011-2012	0.011	2.9*

* Significant at 5 %

FIGURES


Pêches et Océans Canada
Fisheries and Oceans Canada
Régions du Québec et du Golfe
Quebec and Gulf Regions
DIVISIONS et SECTEURS / DIVISIONS and SECTORS :
OPANO / NAFO
Labrador
Québec
Terre-Neuve
Newfoundland
Nouveau-Brunswick
New Brunswick
Nouvelle-Écosse
Nova Scotia
Île du Cap-Breton
Cape Breton Island
Île d'Anticosti
Île de la Madeleine
Port-aux-Basques
Blanc-Sablon
La Tabatière
Port Saunders
Havre-Saint-Pierre
Natashquan
Sept-Îles
Pointe-des-Monts
Baie-Comeau
Sainte-Anne-des-Monts
Matane
Gaspé
Rimouski
Rivière-du-Loup
Bathurst
Caraquet
Miscou
Miquelon
Chéticamp
Moncton
Truro
Halifax
Corner Brook
4Sw
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4Sy
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4Si
4Sx
4Rc
4Ss
4Rd
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4Tn
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4Tl
4TJ
3Ps
1PE / IPE
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4Th
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4VN
Étals-Unis
United States
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Dernière mise à jour / last update 07/09/2004 Réalisation Signep / Realization Prema
0 100 200
Km
Point LATITUDE NORD / NORTH LONGITUDE OUEST / WEST
d m s d m s
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2 49 23 00 65 50 00
3 50 02 00 65 50 00
4 50 15 00 65 50 00
5 49 25 00 64 40 00
6 49 45 00 64 15 00
7 49 56 00 64 00 00
8 50 02 00 64 00 00
9 50 02 00 62 56 00
10 49 39 00 61 10 00
11 50 11 00 61 10 00
12 49 25 00 60 00 00
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18 49 24 00 58 14 00
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21 49 00 00 60 00 00
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23 48 42 00 62 32 00
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25 47 50 00 60 00 00
26 47 37 00 59 19 00
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28 46 50 00 58 50 00
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34 47 03 00 60 36 00
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d : degré / degree m : minute s : seconde / second

Figure 1. NAFO unit areas and subdivisions in the Estuary and Gulf of St. Lawrence.

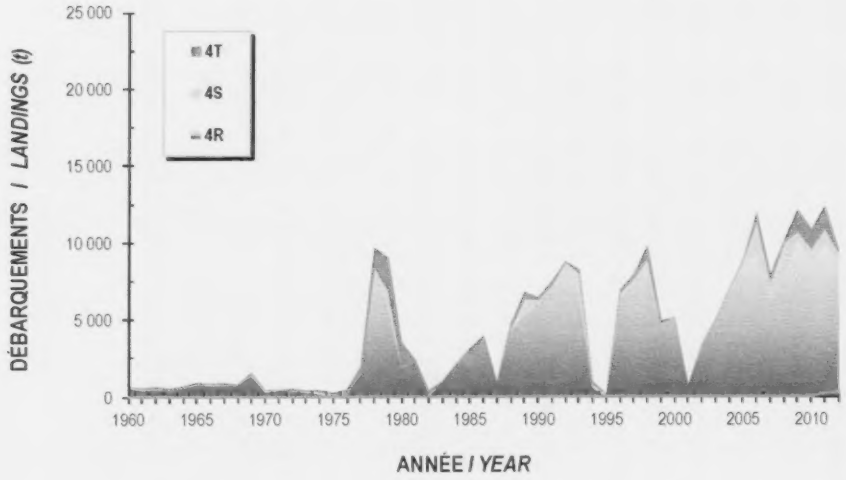


Figure 2. Capelin landings (t) in NAFO Divisions 4RST (Estuary and Gulf of St. Lawrence) since 1960.

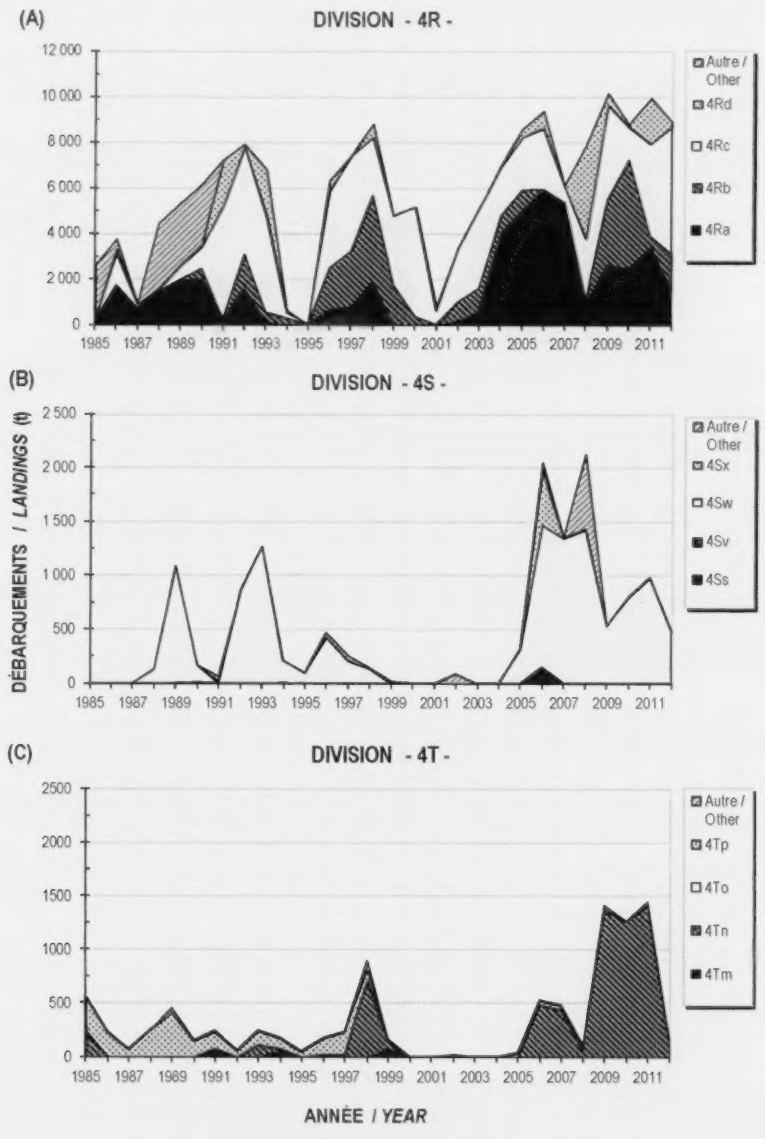


Figure 3. Landings (t) of capelin in the unit areas of NAFO Divisions 4R (A), 4S (B), and 4T (C), from 1985 to 2012.

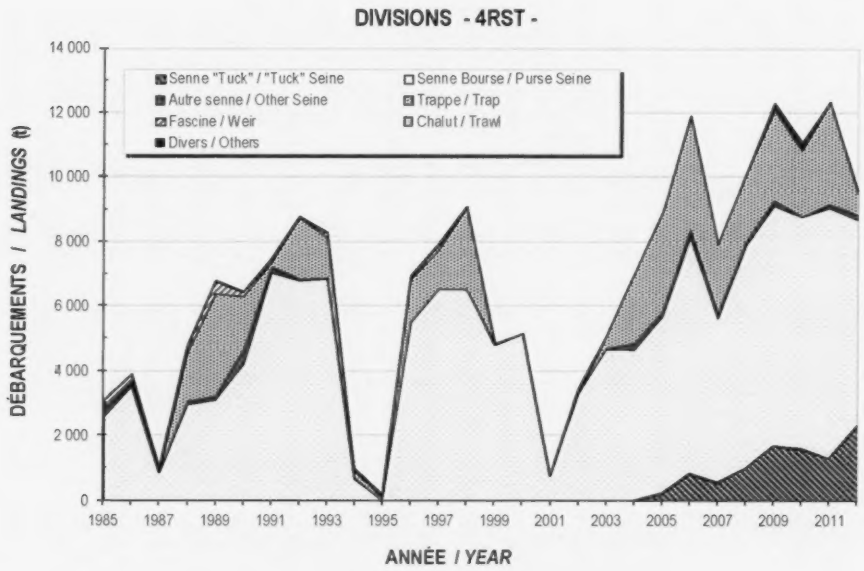


Figure 4. Landings (t) of capelin in NAFO Divisions 4RST, from 1985 to 2012.

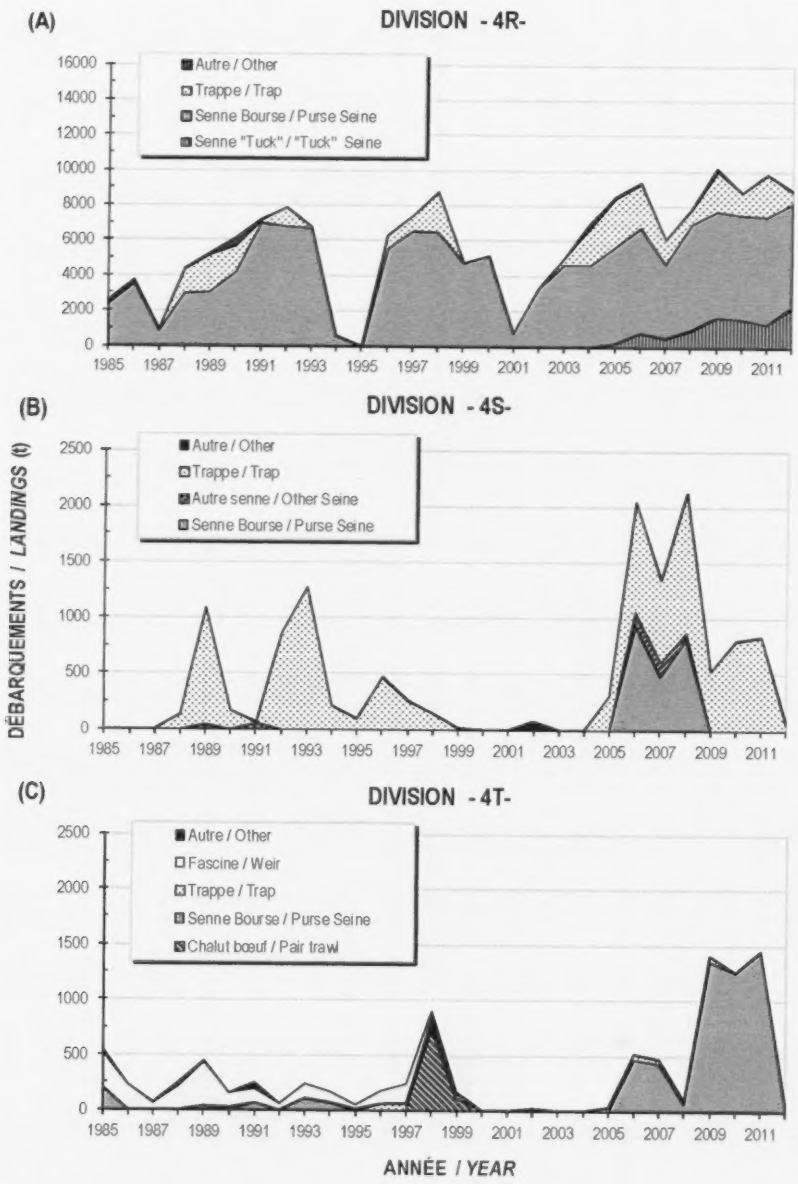


Figure 5. Landings (t) of capelin by fishing gear in NAFO Divisions 4R (A), 4S (B), and 4T (C), from 1985 to 2012.

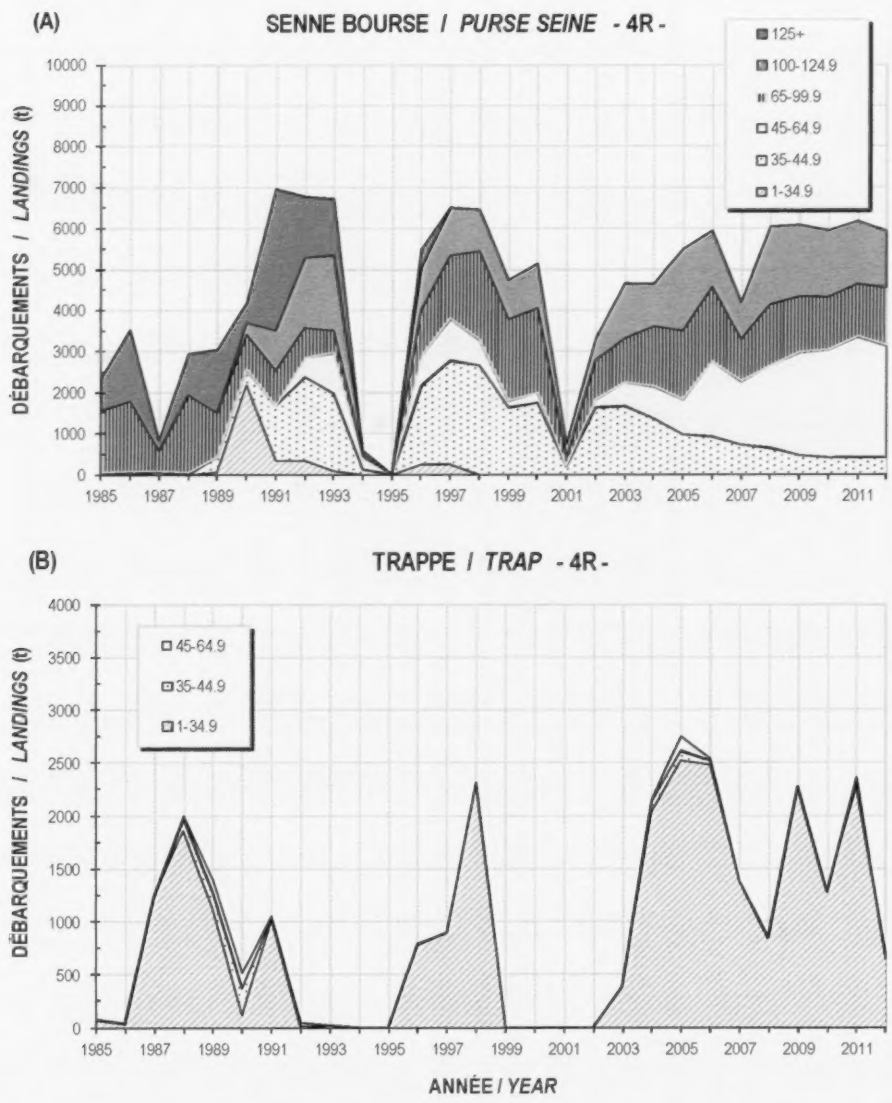


Figure 6. Landings (t) of capelin by length class of the purse seiners (A) and of the vessels fishing with trap (B) in NAFO Division 4R, from 1985 to 2012.

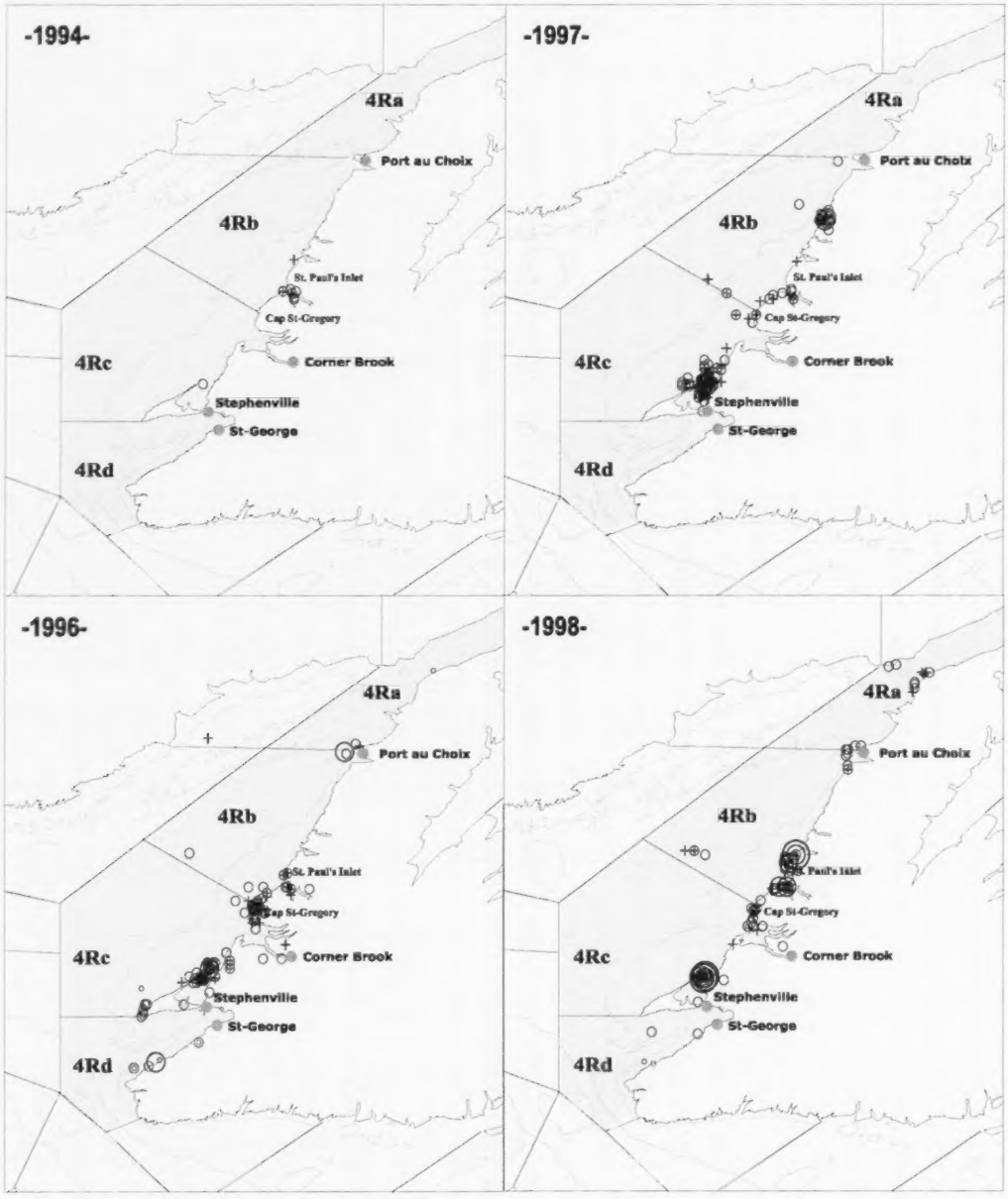
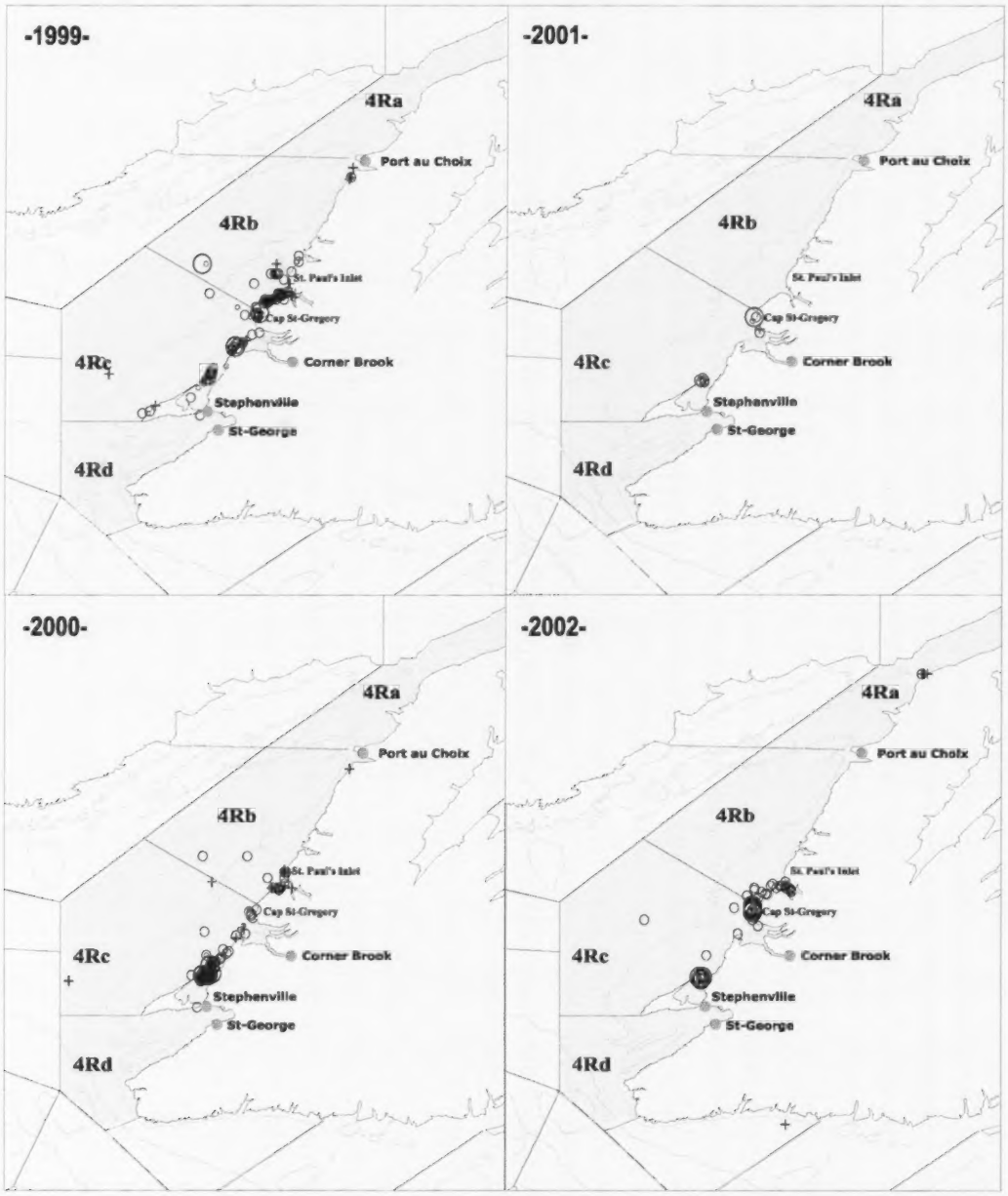


Figure 7. Positions of the capelin catches (t) by the large and small seiners of the west coast of Newfoundland (NAFO Division 4R), from 1994 to 2012.



Légende / Legend :

· 0 - 10 ◦ 10 - 50 ○ 50 - 100 ○ 100 - 150 ○ > 150 t

Figure 7. (Continued).

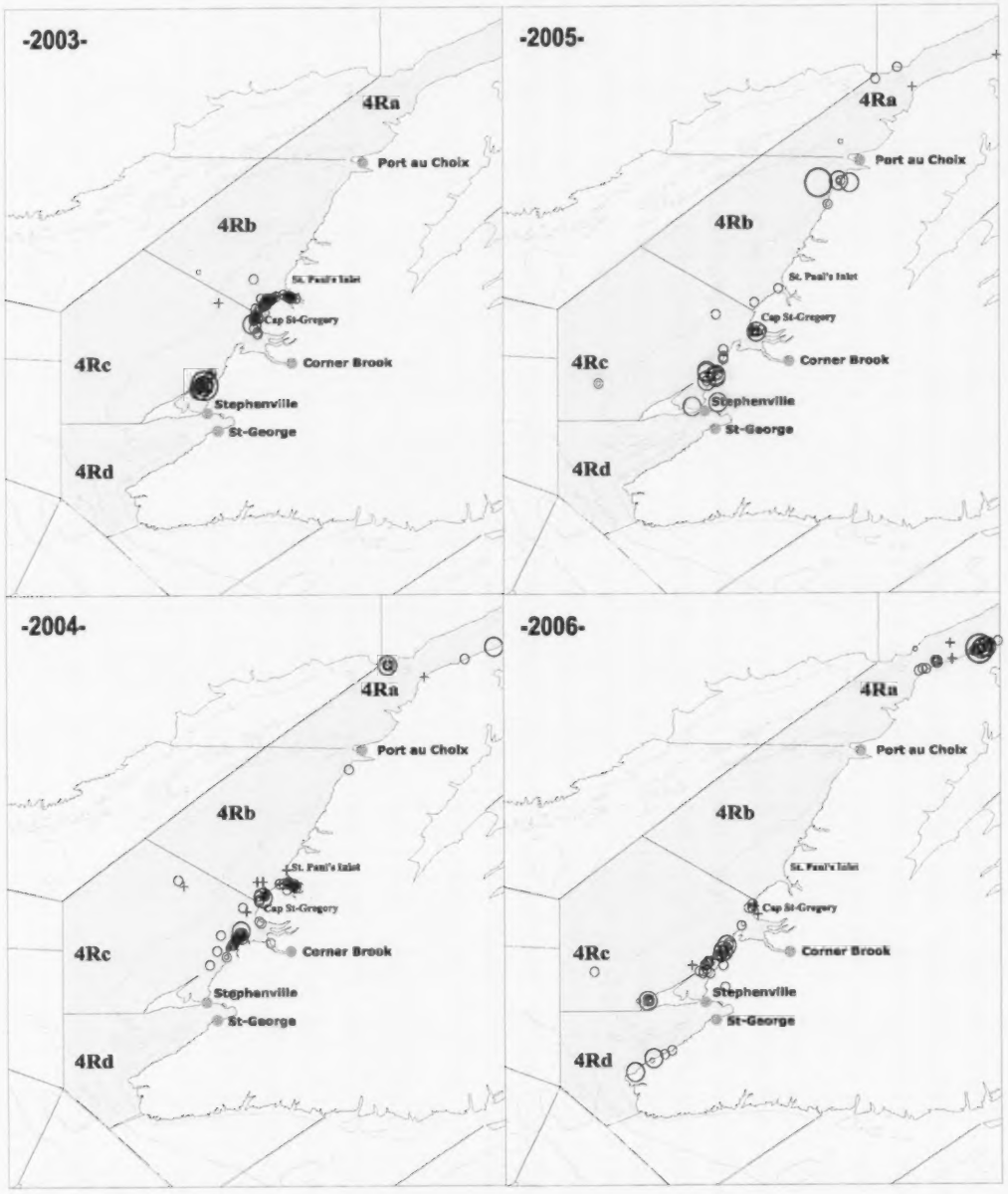


Figure 7. (Continued).

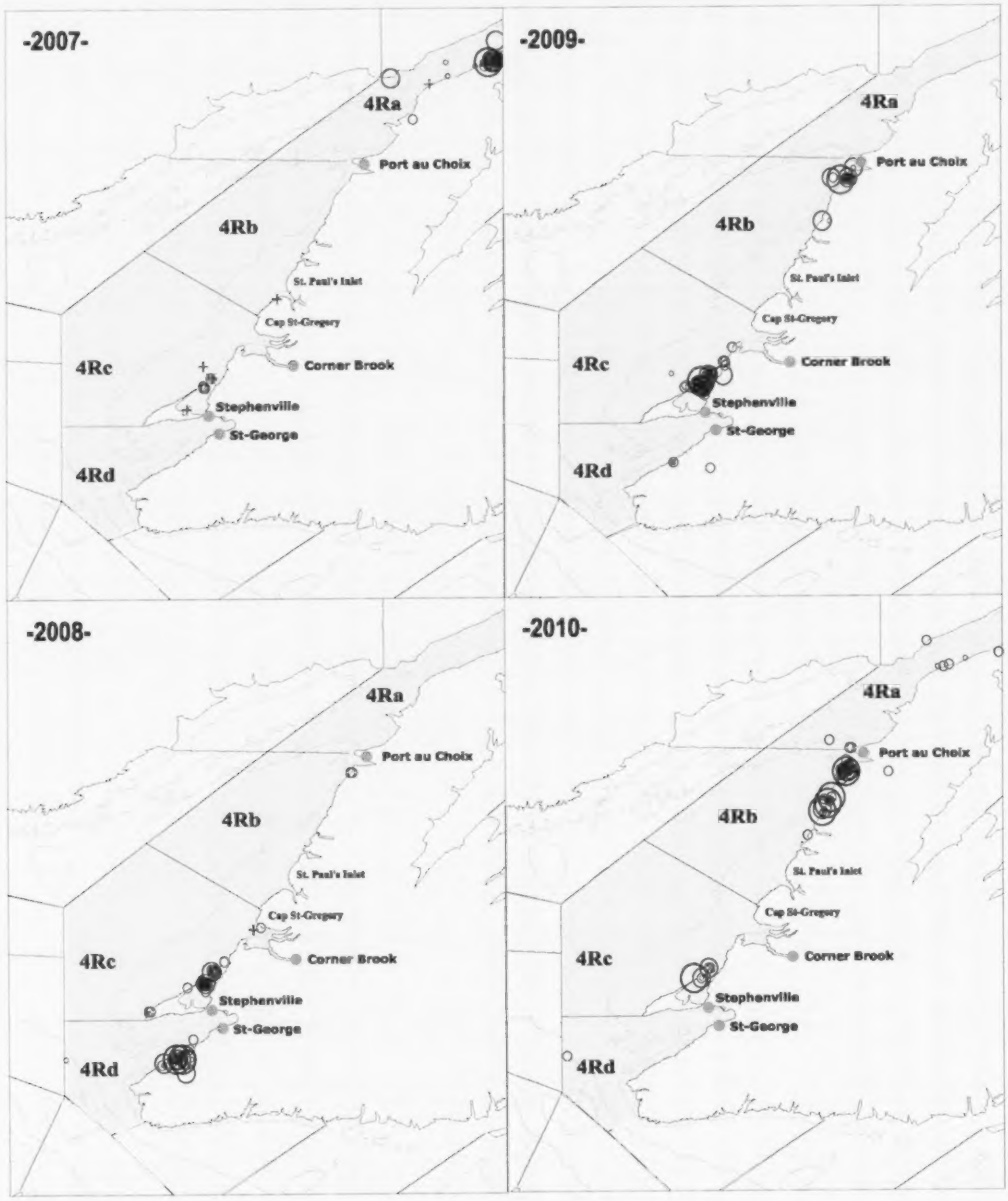


Figure 7. (Continued).

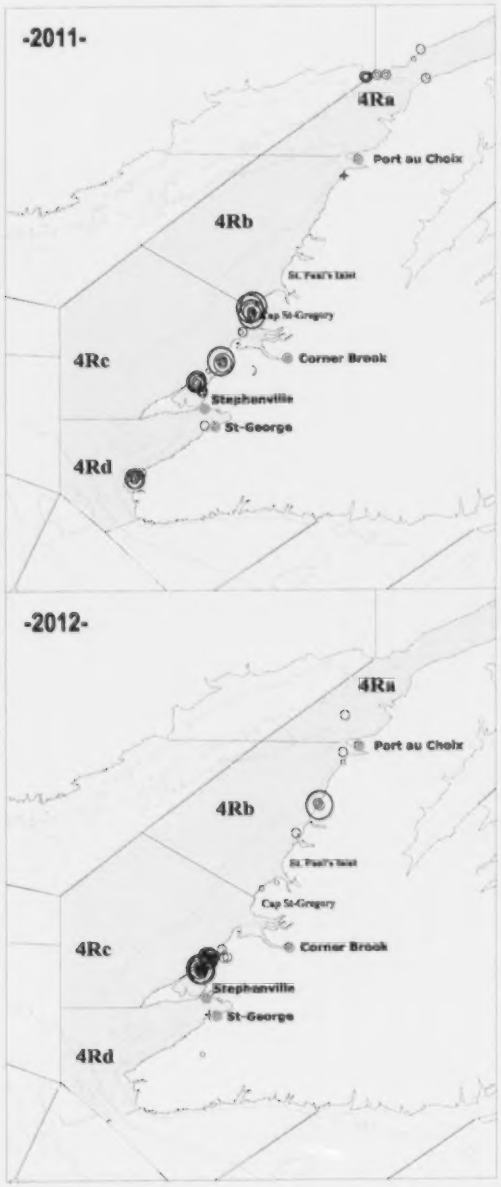


Figure 7. (Continued).

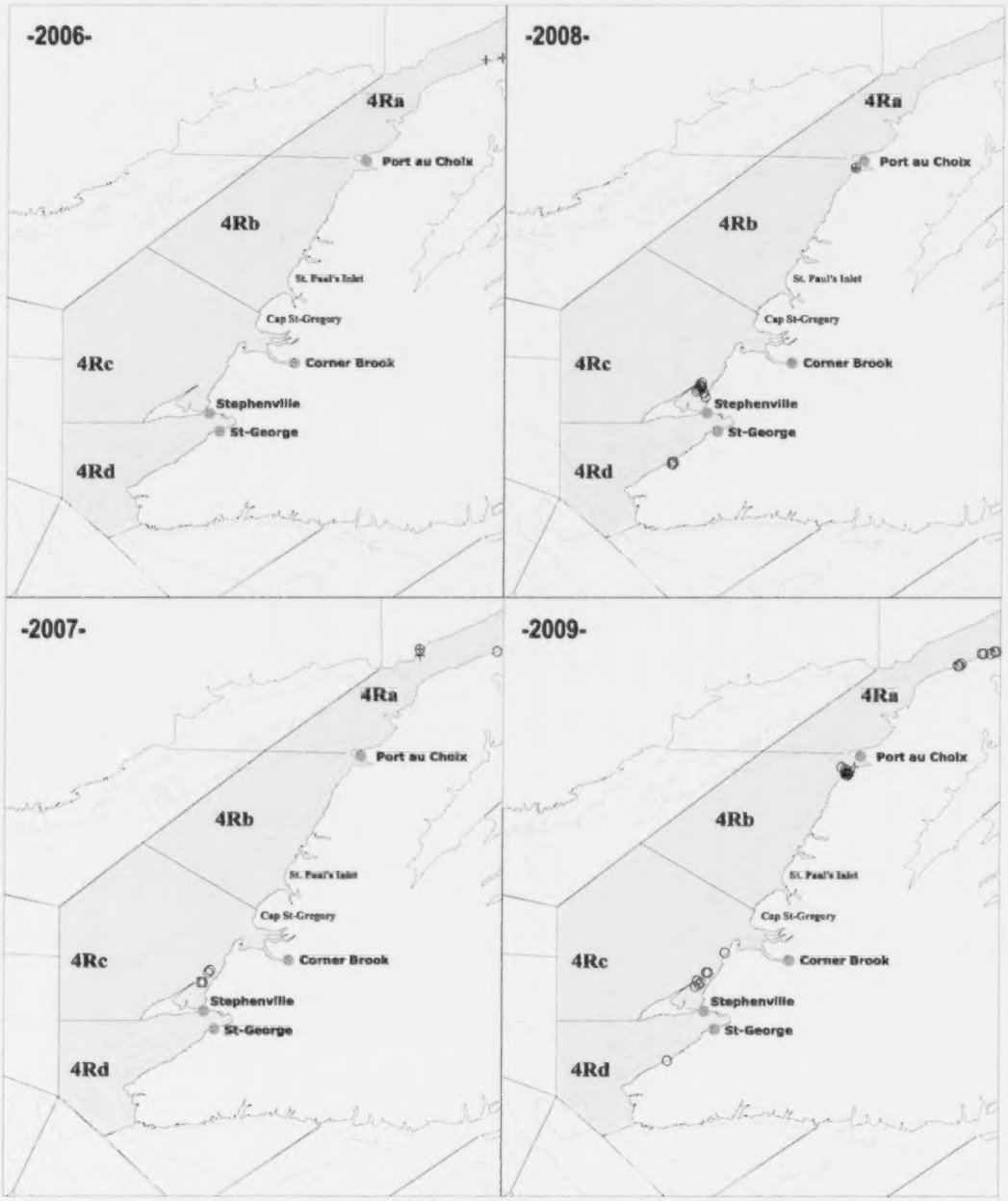


Figure 8. Positions of the capelin catches (t) by "Tuck" seine on the west coast of Newfoundland (NAFO Division 4R), from 2006 to 2012.

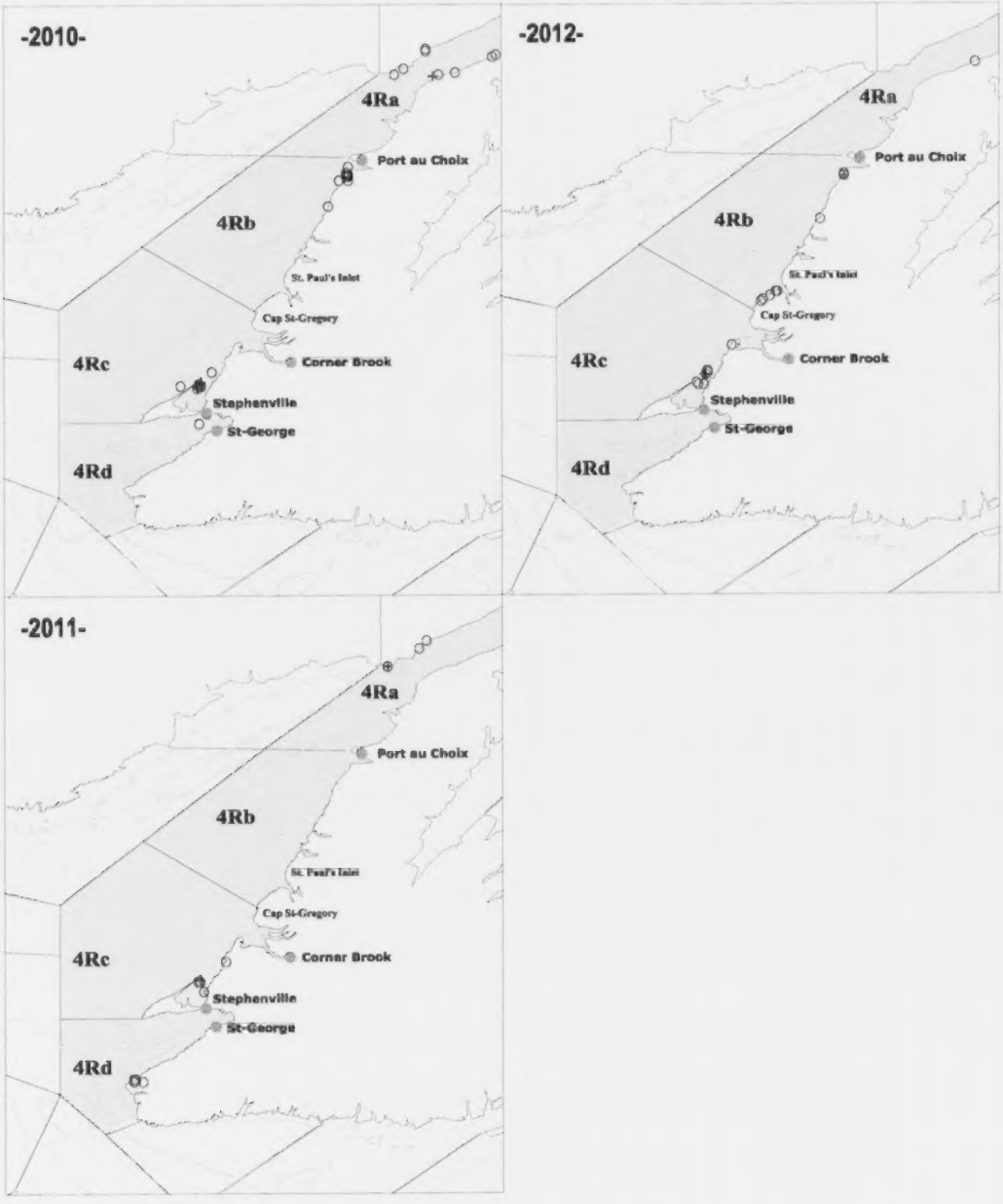


Figure 8. (Continued).

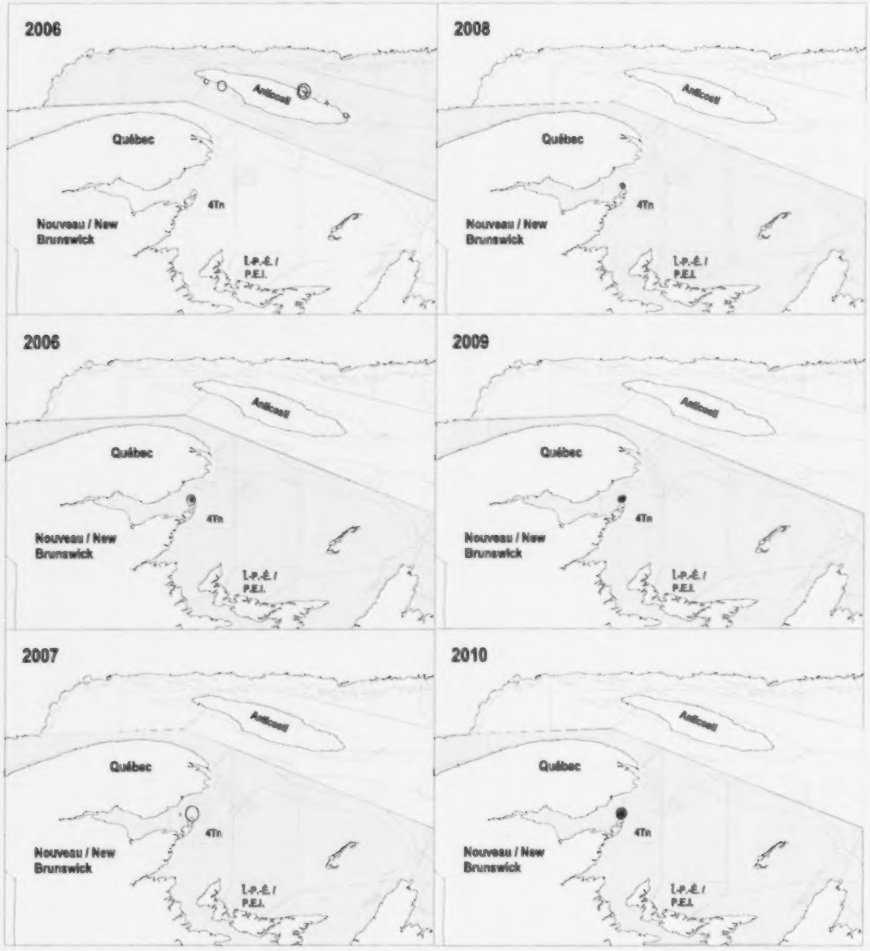
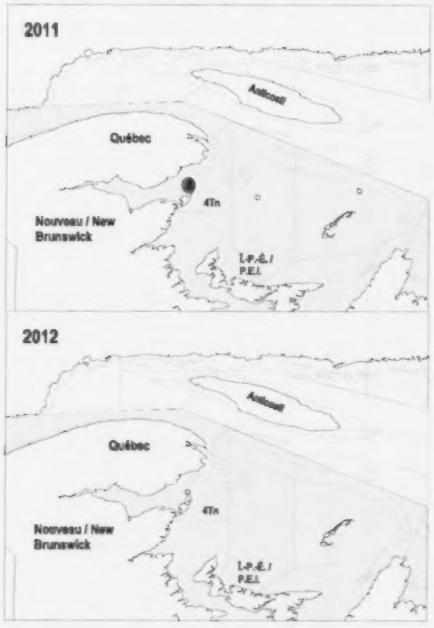


Figure 9. Positions of the capelin catches (t) by seiners on the Quebec North Shore (NAFO Division 4S) in 2006 and in the southern Gulf of St. Lawrence (NAFO Division 4T), from 2006 to 2012.



Légende / Legend :

· 0 - 10 · 10 - 50 ○ 50 - 100 ○ 100 - 150 ○ > 150 t

Figure 9. (Continued).

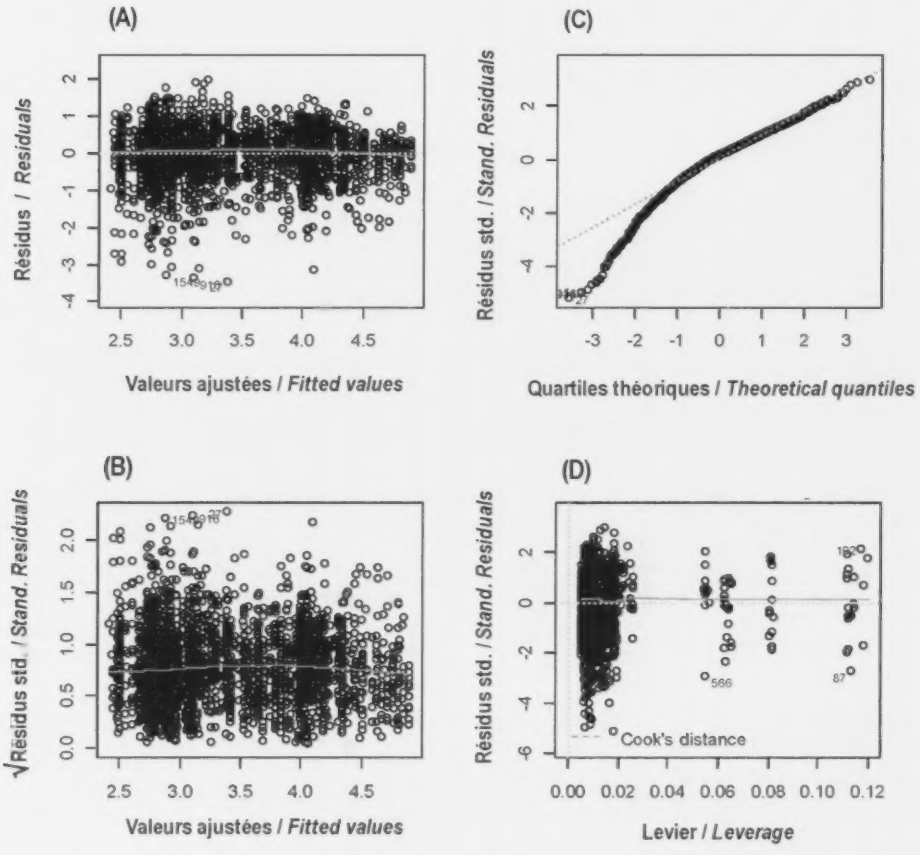


Figure 10. Diagnostics of the multiplicative model used to standardize the capelin catches per unit of effort (performance) (t/day) of the purse seine fishery in NAFO Division 4R, from 1986 to 2012 (A : residuals vs fitted values of the model, B : square root of the absolute values of the residuals vs fitted values of the model, C: q-q plot of the residuals, and D: graph of the standardized residuals vs leverage and Cook's distance).

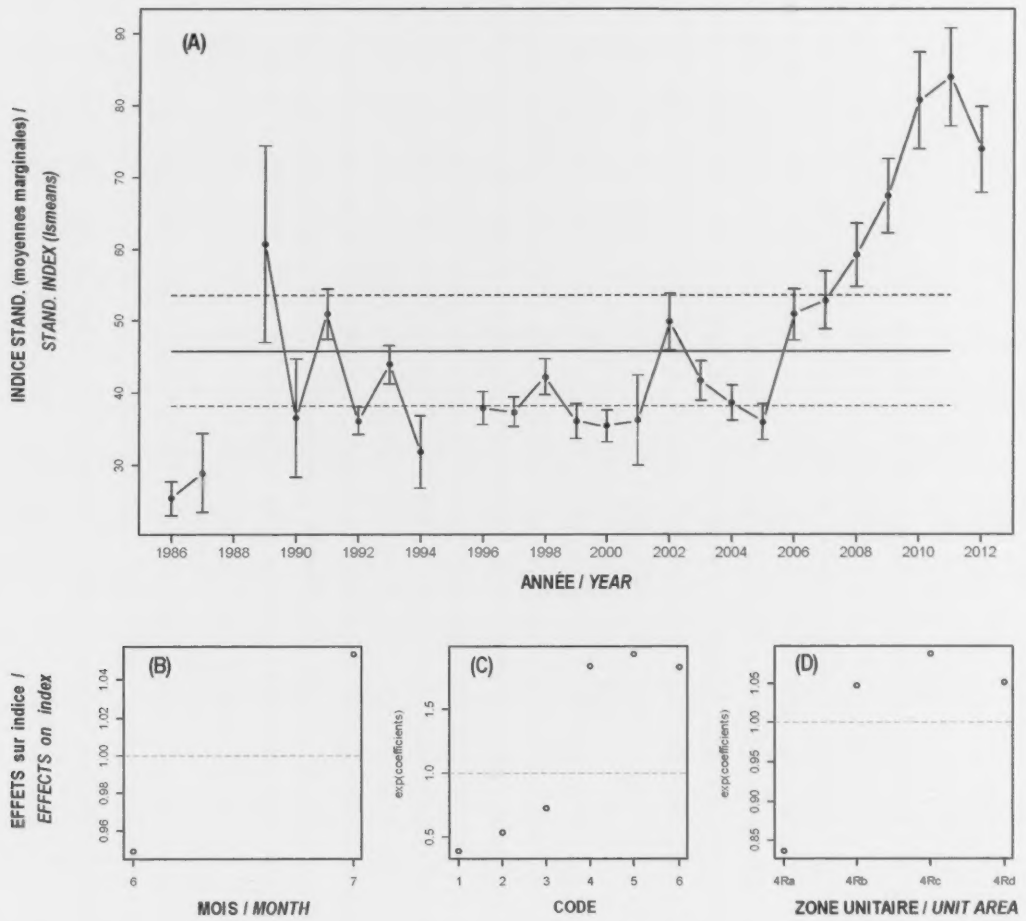


Figure 11. Performance (t/day) of the west coast of Newfoundland (NAFO Division 4R) purse seine fishery measured by a standardized index (marginal means or lsmeans) of the catches per unit of effort : (A) year, (B) month, (C) length code, and (D) unit area. The horizontal lines in A indicate the average of the 1986-2011 period ± 0.5 x standard deviation (vertical lines represent the standard errors).

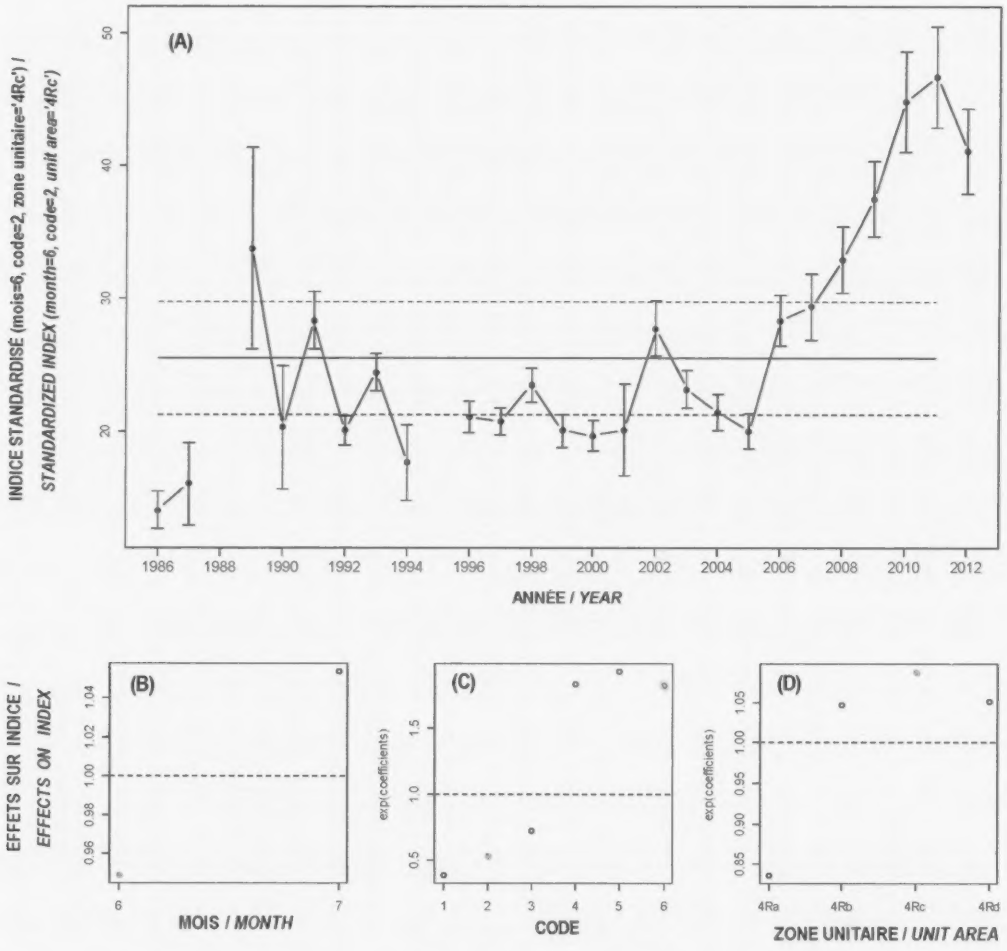


Figure 12. Performance (t/day) of the west coast of Newfoundland (Division 4R) purse seine fishery measured by a standardized index of the catch per unit effort: (A) year, (B) month, (C) length code, and (D) unit area. The horizontal lines in A indicate the average of the 1986-2011 period ± 0.5 x standard deviation (vertical lines represent the standard errors).The coloured circles in B, C, and D indicate the values of the factors used in the standardization.

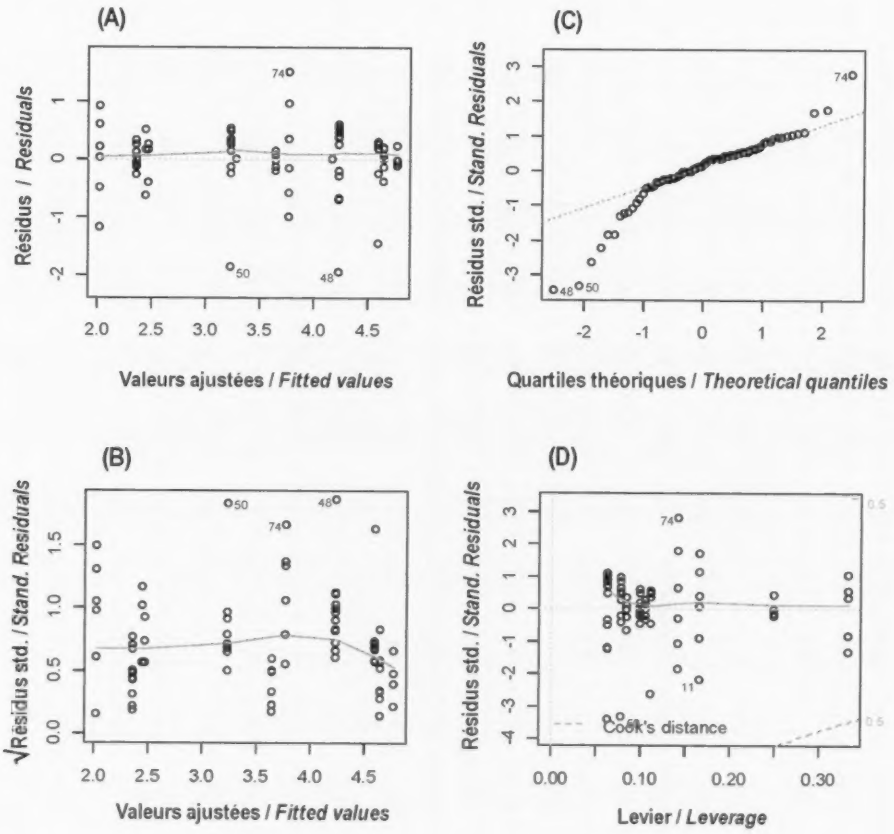


Figure 13. Diagnostics of the multiplicative model used to standardize the capelin catches per unit of effort (performance) (t/day) of the purse seine fishery in unit area 4Tn, from 1993 to 2011 (only one catch in 2012) (A : residuals vs fitted values of the model, B : square root of the absolute values of the residuals vs fitted values of the model, C: q-q plot of the residuals, and D: graph of the standardized residuals vs leverage and Cook's distance).

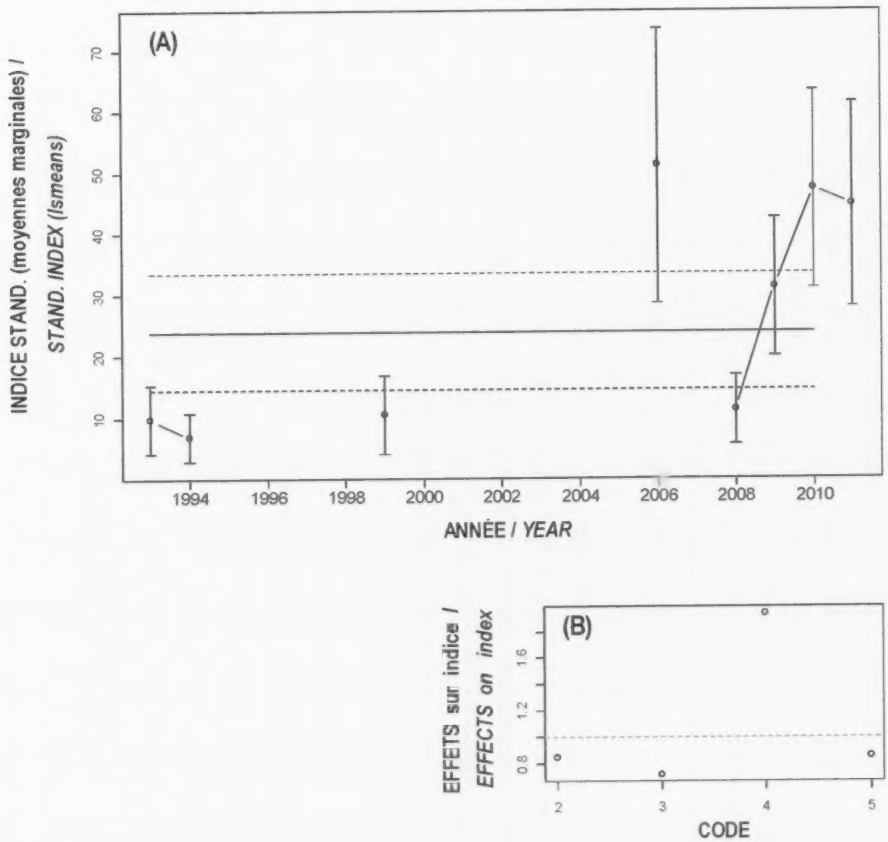


Figure 14. Performance (t/day) of the purse seine fishery in unit area 4Tn as measured by a standardized index (marginal means or lsmeans) of the catches per unit of effort : (A) year and (B) length code. The horizontal lines in A indicate the average of the 1993-2010 period ± 0.5 x standard deviation (vertical lines represent the standard errors).

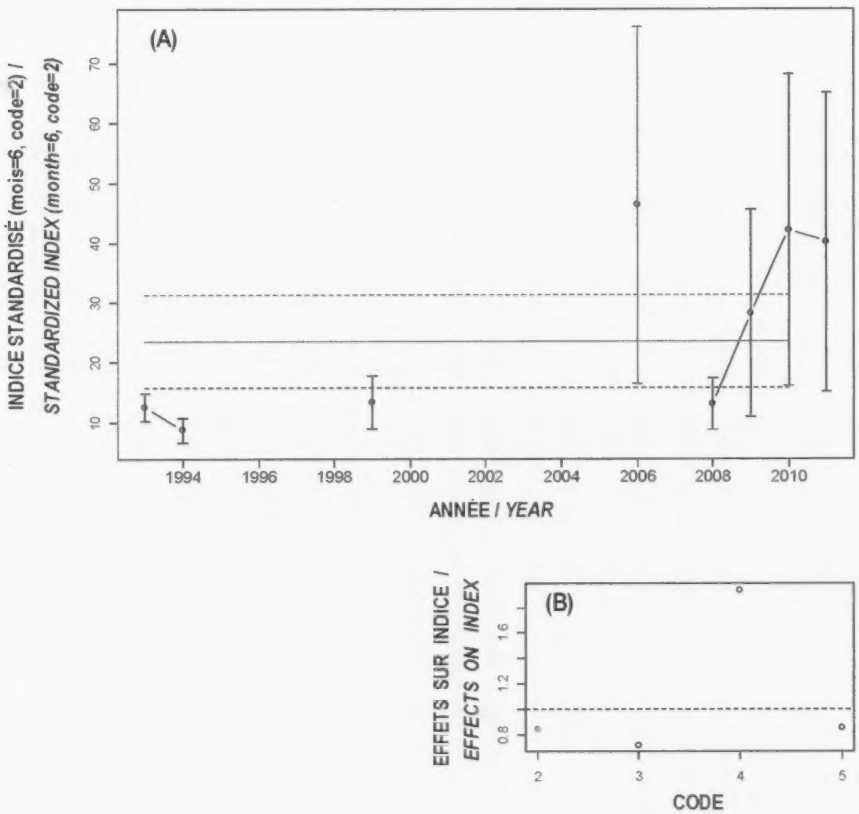


Figure 15. Performance (t/day) of the purse seine fishery in unit area 4Tn as measured by a standardized index of the catches per unit of effort: (A) year and (B) length code. The horizontal lines in A indicate the average of the 1993-2010 period ± 0.5 x standard deviation (vertical lines represent the standard errors).The coloured circle in B indicates the value of the factor used in the standardization.

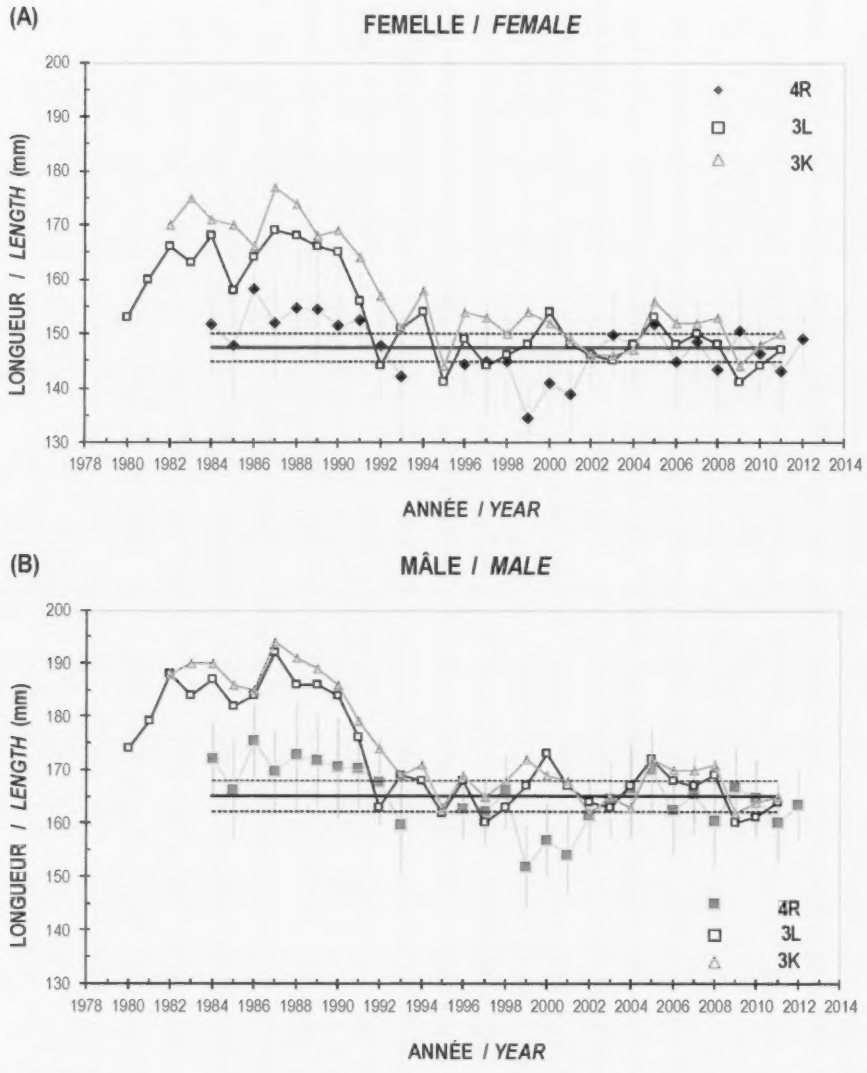


Figure 16. Mean length (mm) of females (A) and males (B) capelin caught with seines (purse and "Tuck") in NAFO Division 4R since 1984 and in Divisions 3K and 3L since 1982 and 1980 (3K and 3L source of data : Dr. Brian Nakashima, DFO, pers. comm.). The horizontal lines indicate the averages of the 1984-2011 period ± 0.5 x standard deviations for Division 4R (vertical lines represent the standard deviations).

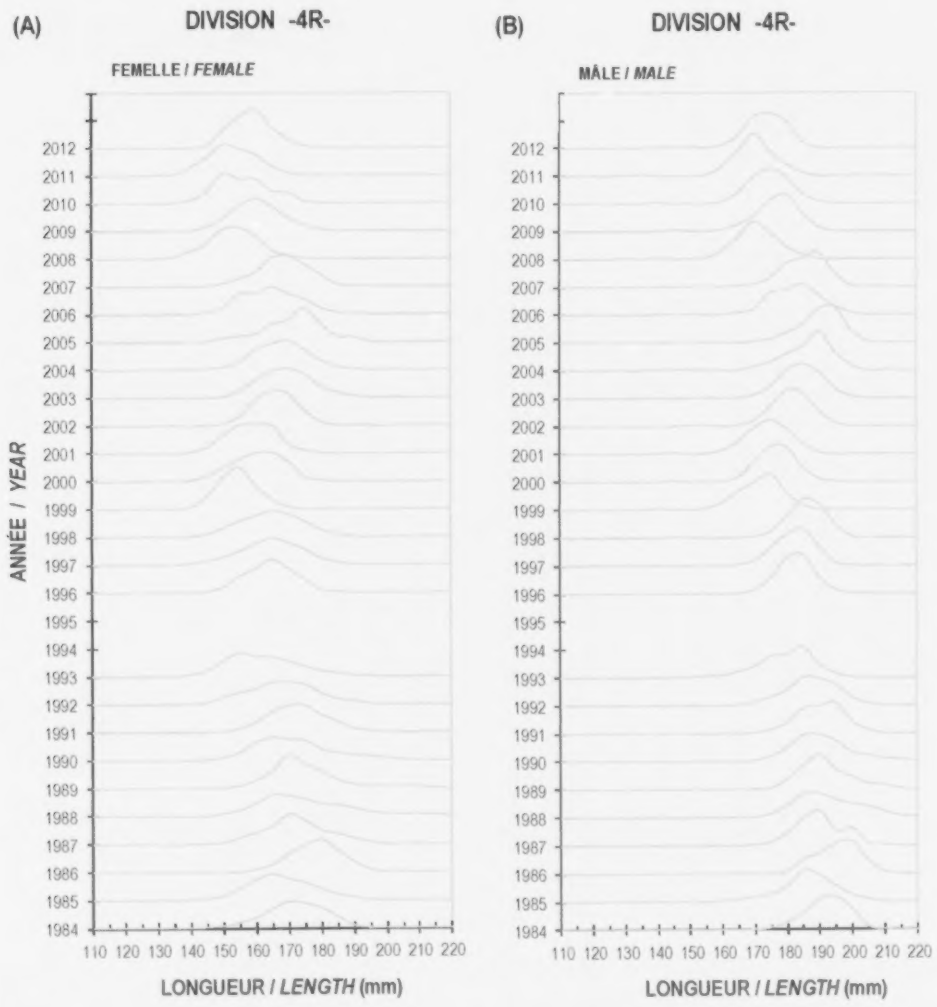


Figure 17. Length (mm) composition of females (A) and males (B) capelin caught with seines (purse and "Tuck") in NAFO Division 4R, from 1984 to 2012 (except 1994 and 1995).

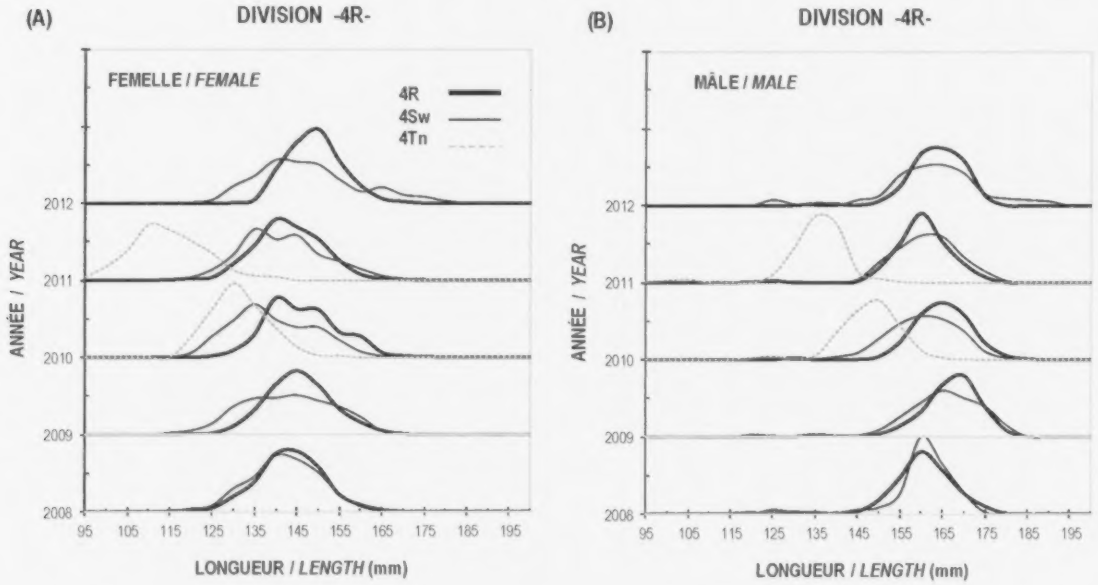


Figure 18. Length (mm) composition of females (A) and males (B) capelin caught with seines (purse and "Tuck") in NAFO Division 4R and unit areas 4Sw and 4Tn, from 2008 to 2012.

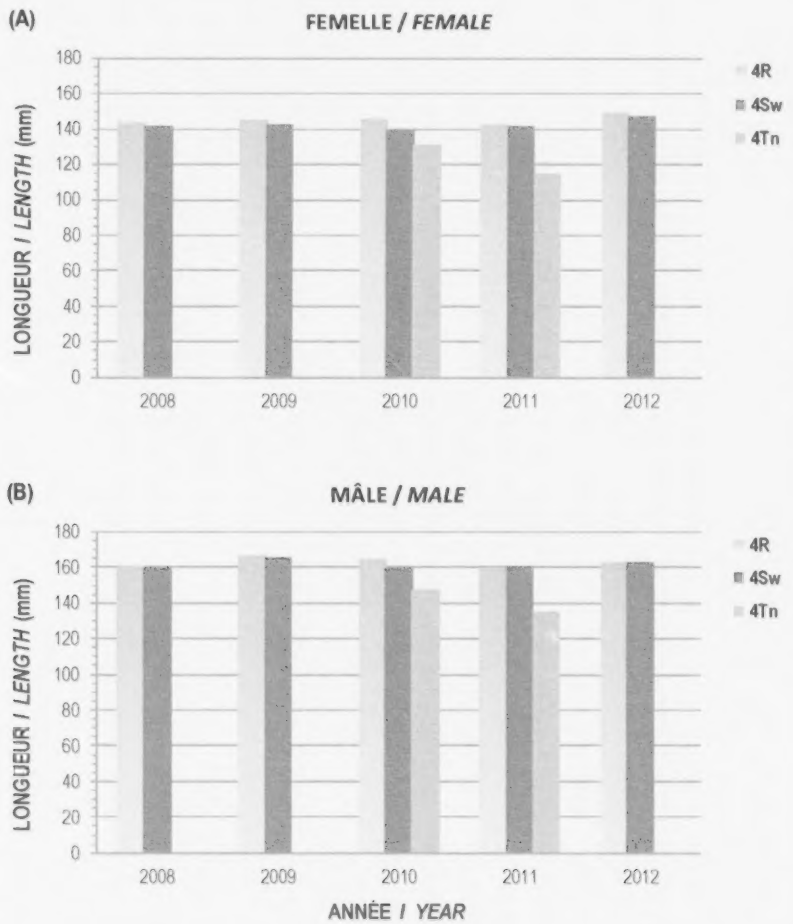


Figure 19. Mean length (mm) of the females (A) and males (B) capelin caught with seines (purse and "Tuck") in NAFO Division 4R and unit areas 4Sw and 4Tn, from 2008 to 2012.

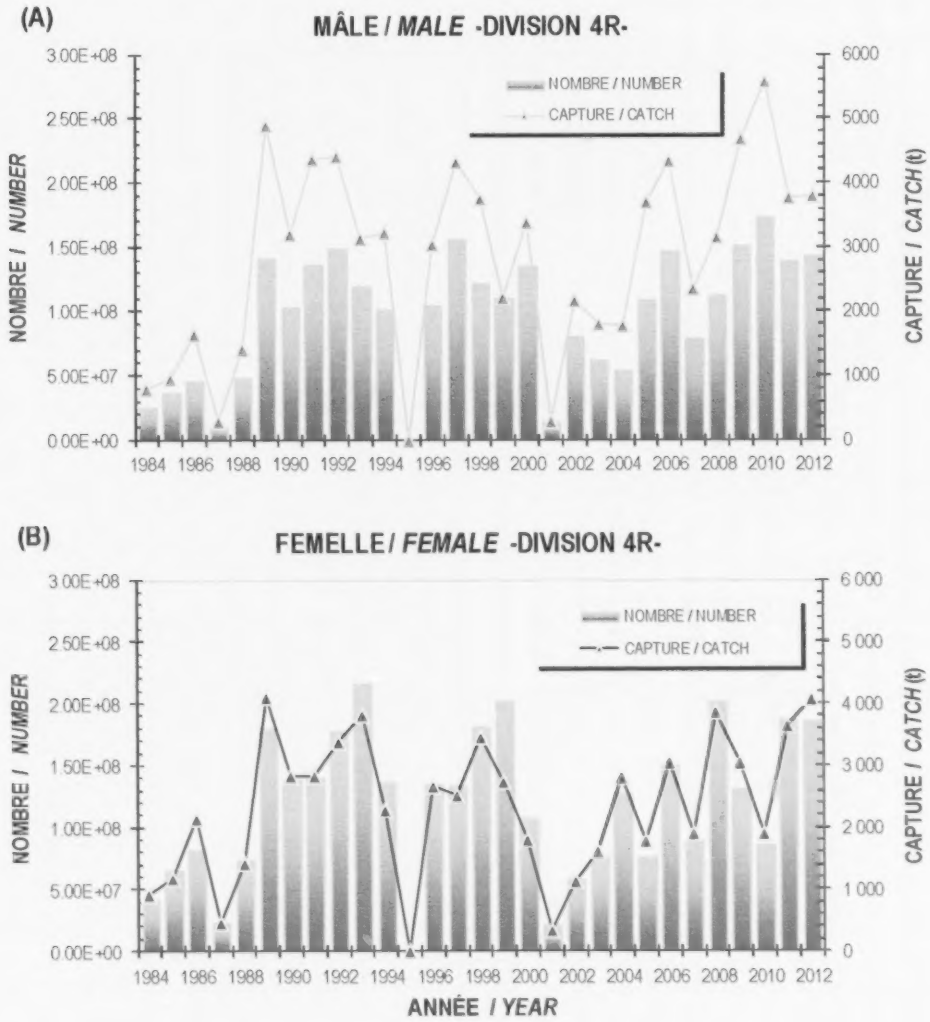


Figure 20. Total catches in number and weight (t) of males (A) and females (B) capelin caught by the commercial fishery in NAFO Division 4R since 1984.

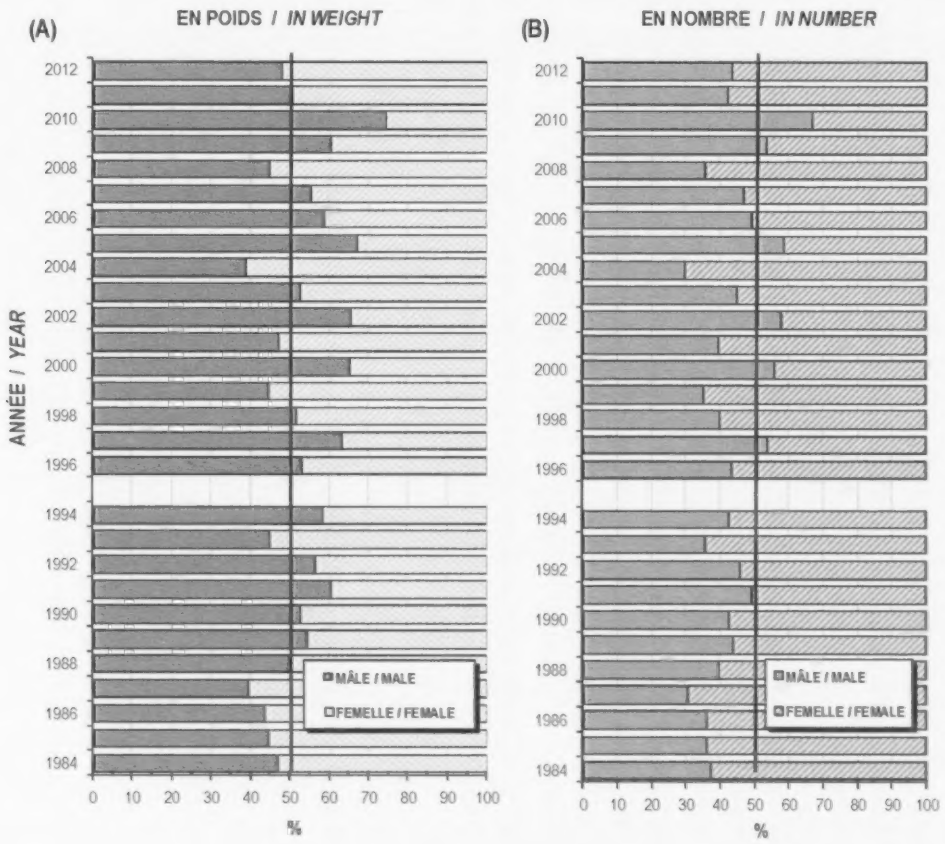


Figure 21. Percentages estimated in weight (A) and in number (B) of the females and males capelin in the commercial fishery of NAFO Division 4R.

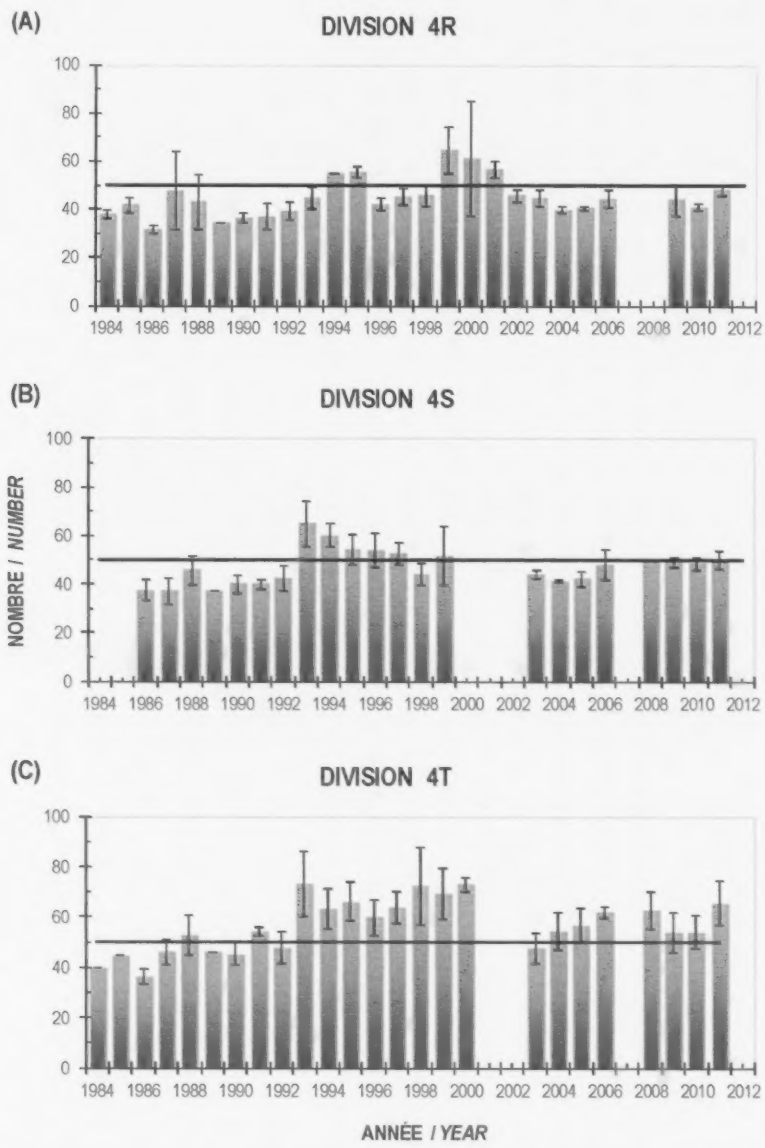


Figure 22. Mean number (and standard deviation) of capelin per kilogram for NAFO Divisions 4RST, from 1984 to 2011 (horizontal lines represent the 50 capelin per kilogram limit).

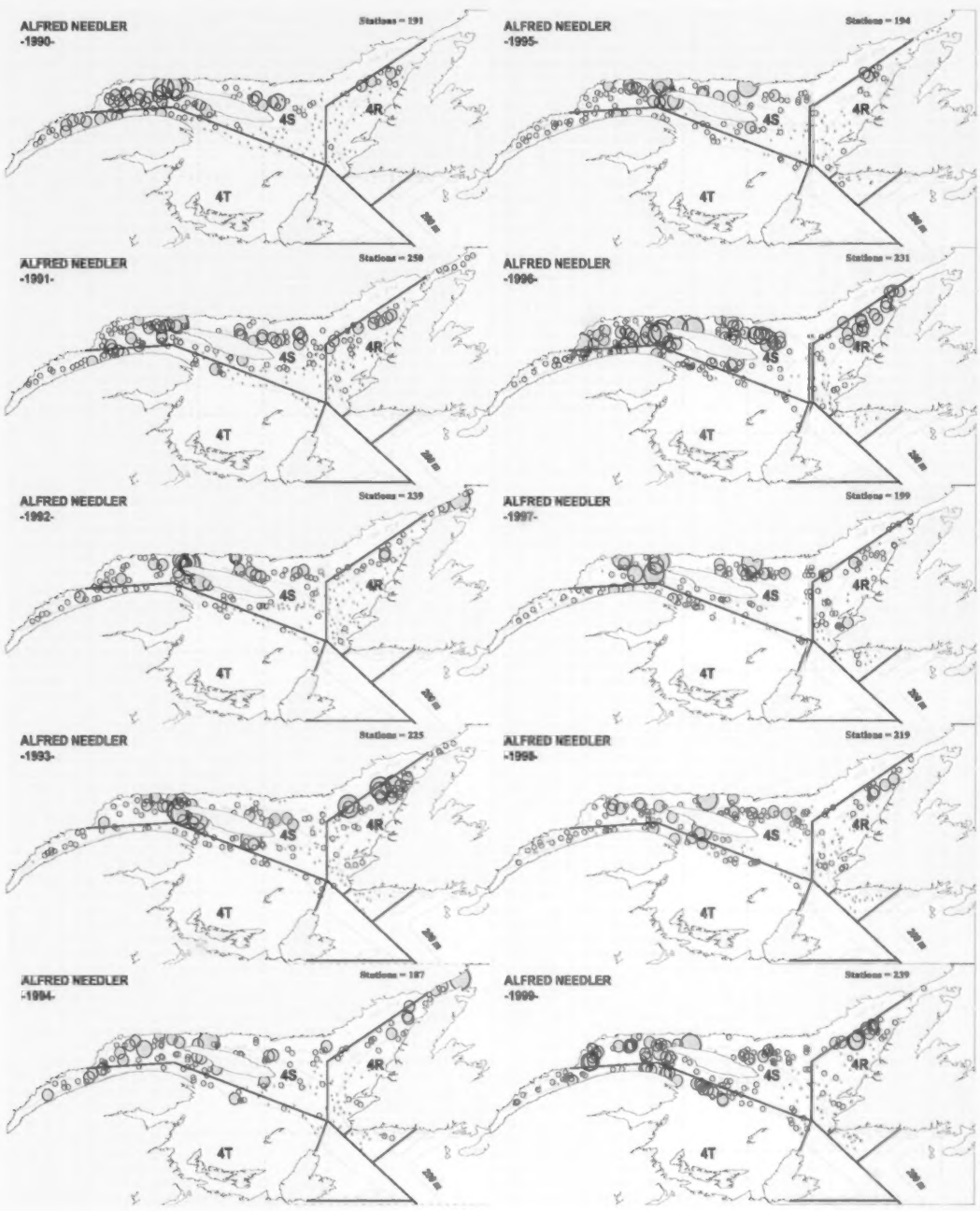


Figure 23. Maps of capelin catches (kg/set) from the groundfish and shrimp multidisciplinary surveys conducted in August in the Estuary and northern Gulf of St. Lawrence, from 1990 to 2012.

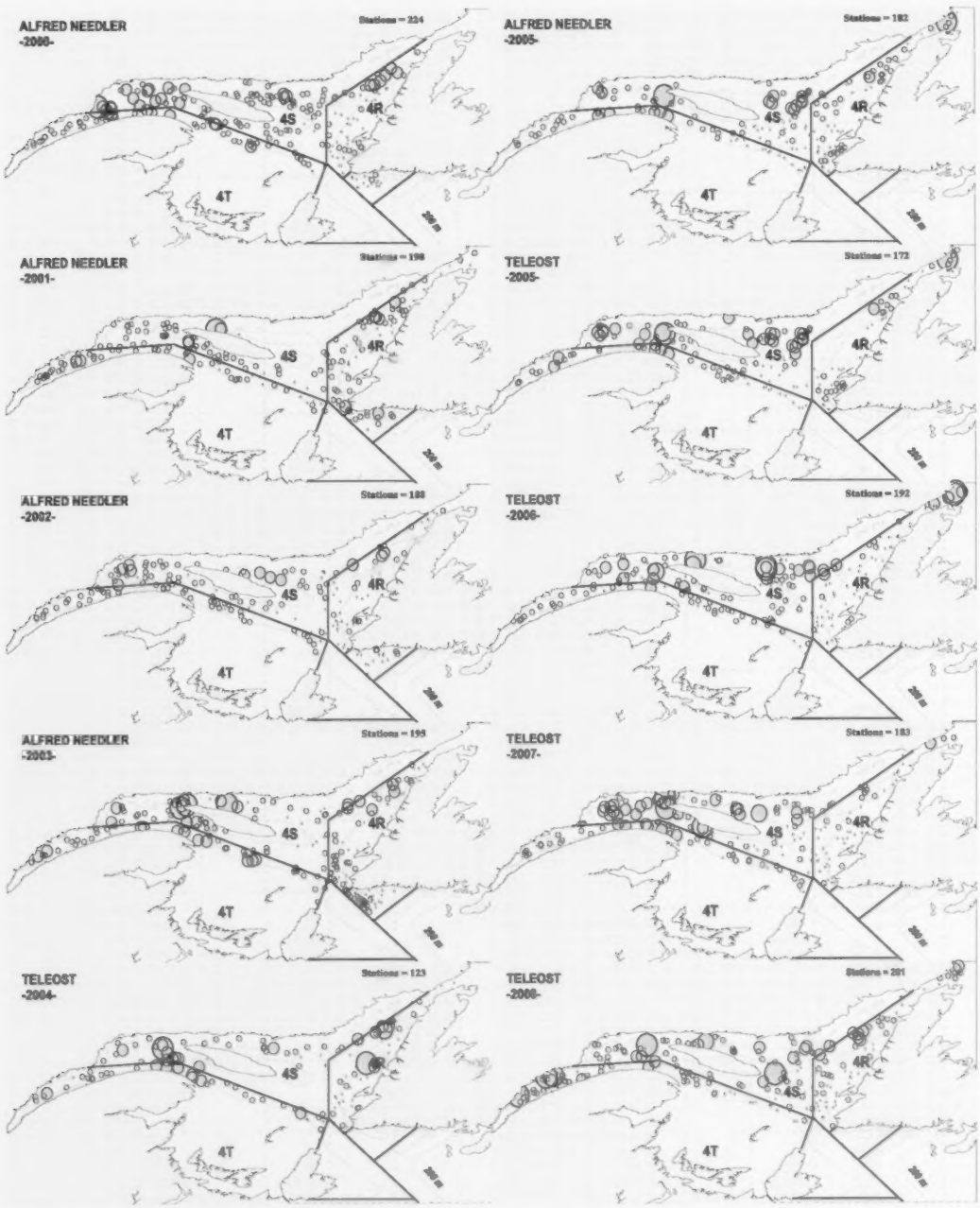


Figure 23. (Continued).

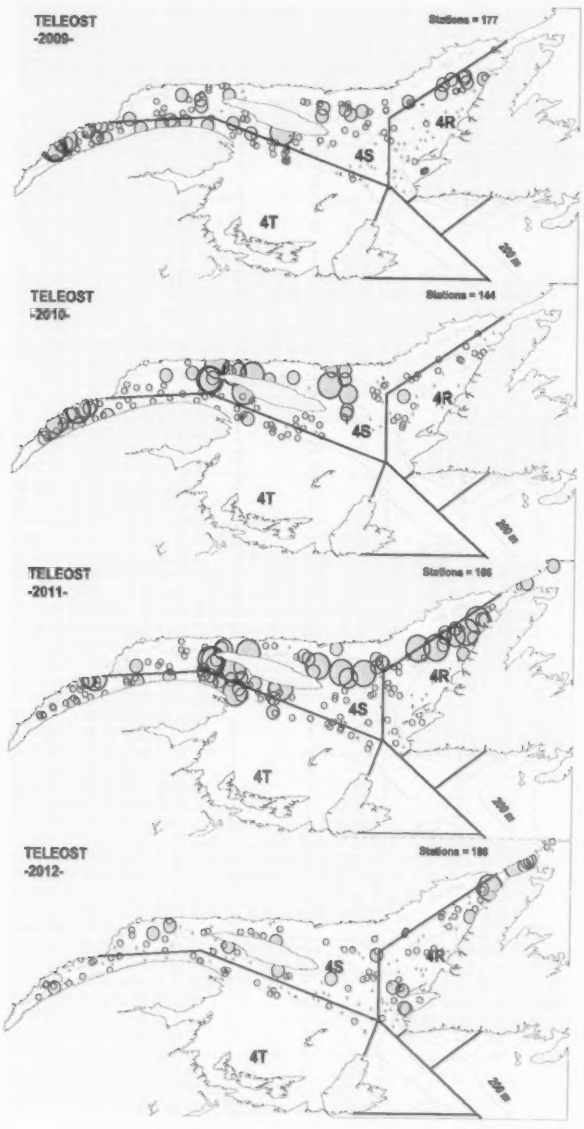


Figure 23. (Continued).

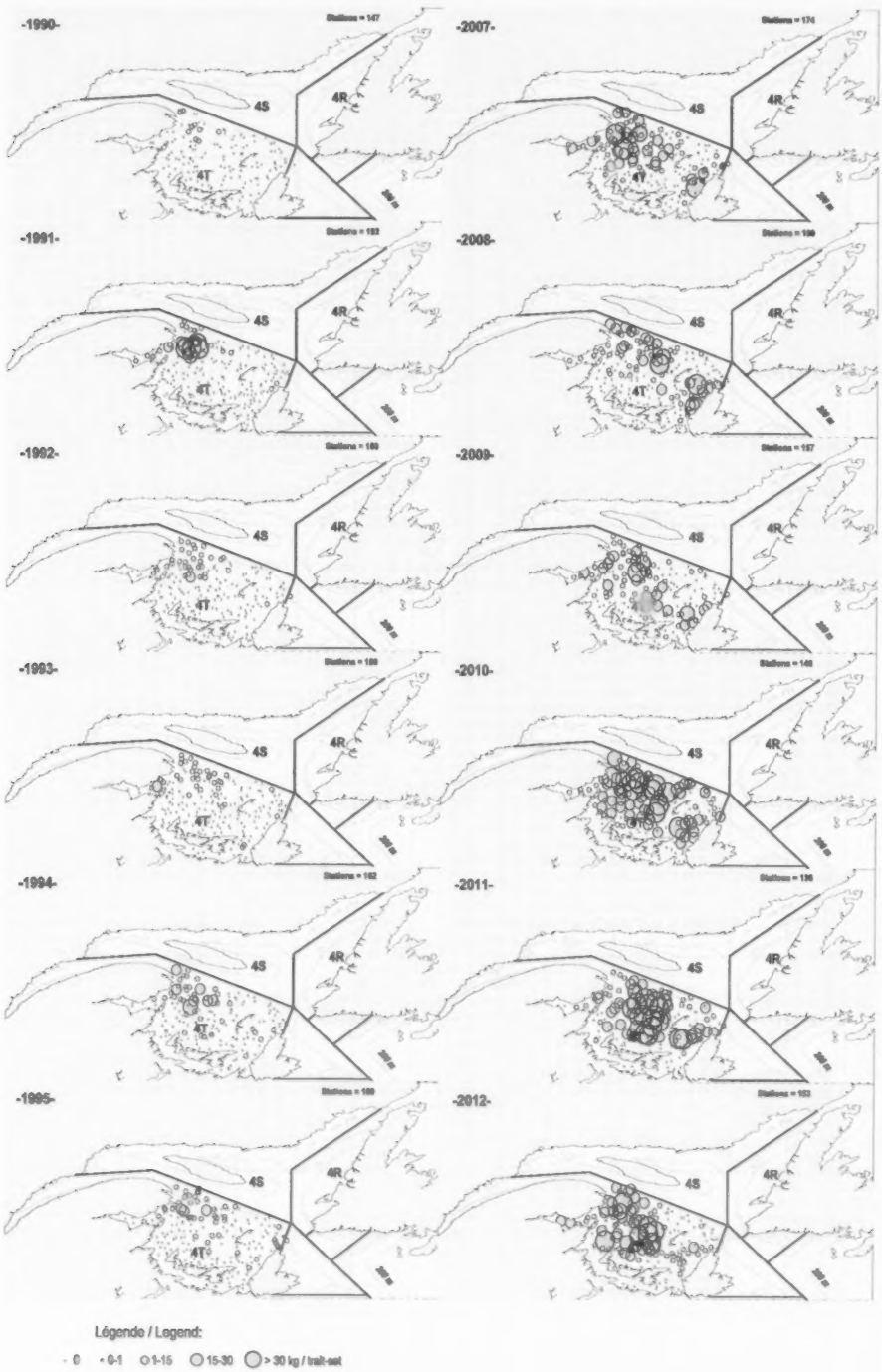


Figure 24. Maps of capelin catches (kg/set) from the groundfish multidisciplinary surveys conducted in September in the southern Gulf of St. Lawrence, from 1990 to 1995 and from 2007 to 2012.

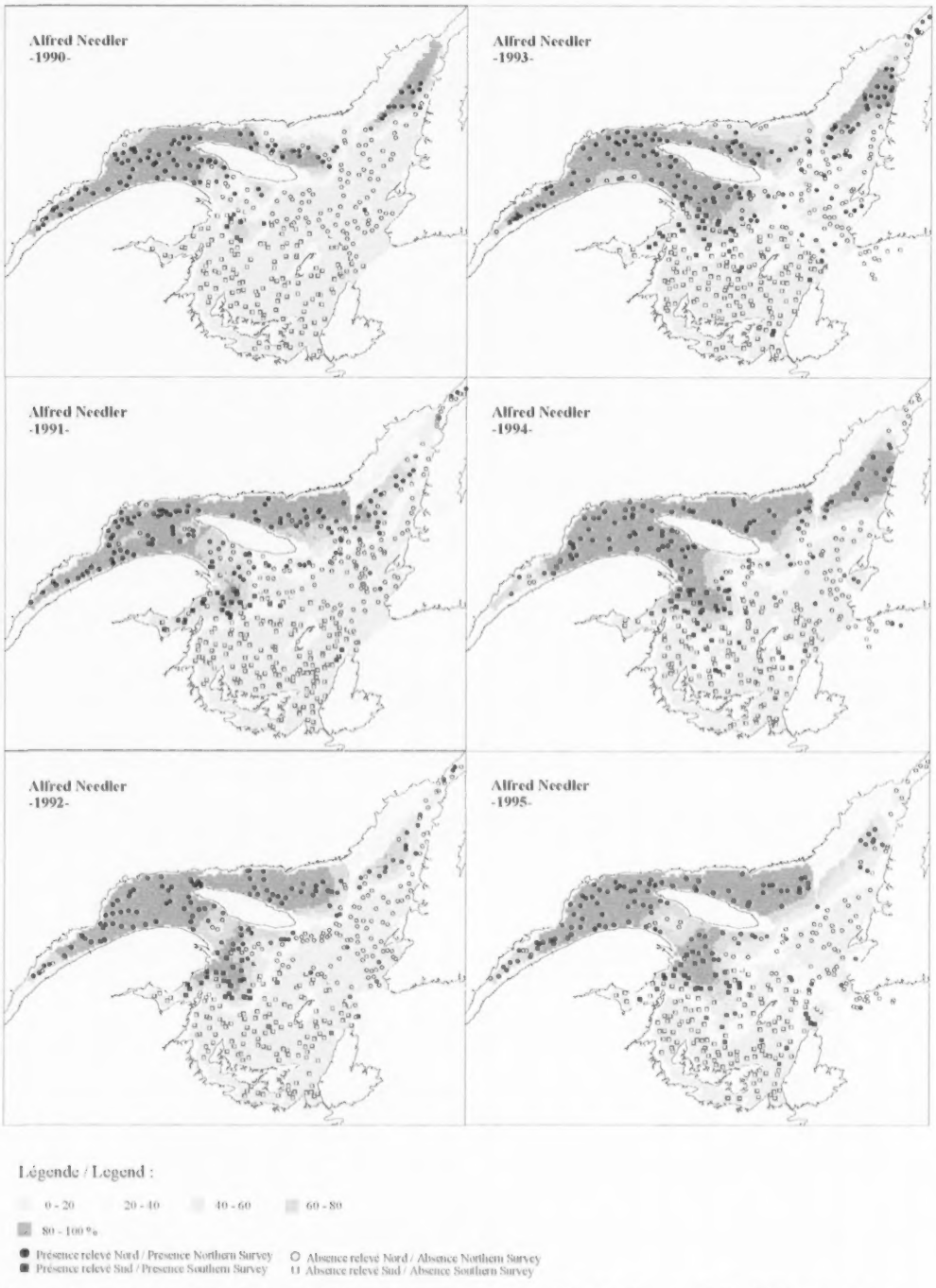


Figure 25. Surfaces probabilities (%) of the presence of capelin for the multidisciplinary surveys conducted in the Estuary, the northern, and the southern Gulf of St. Lawrence, from 1990 to 2012.

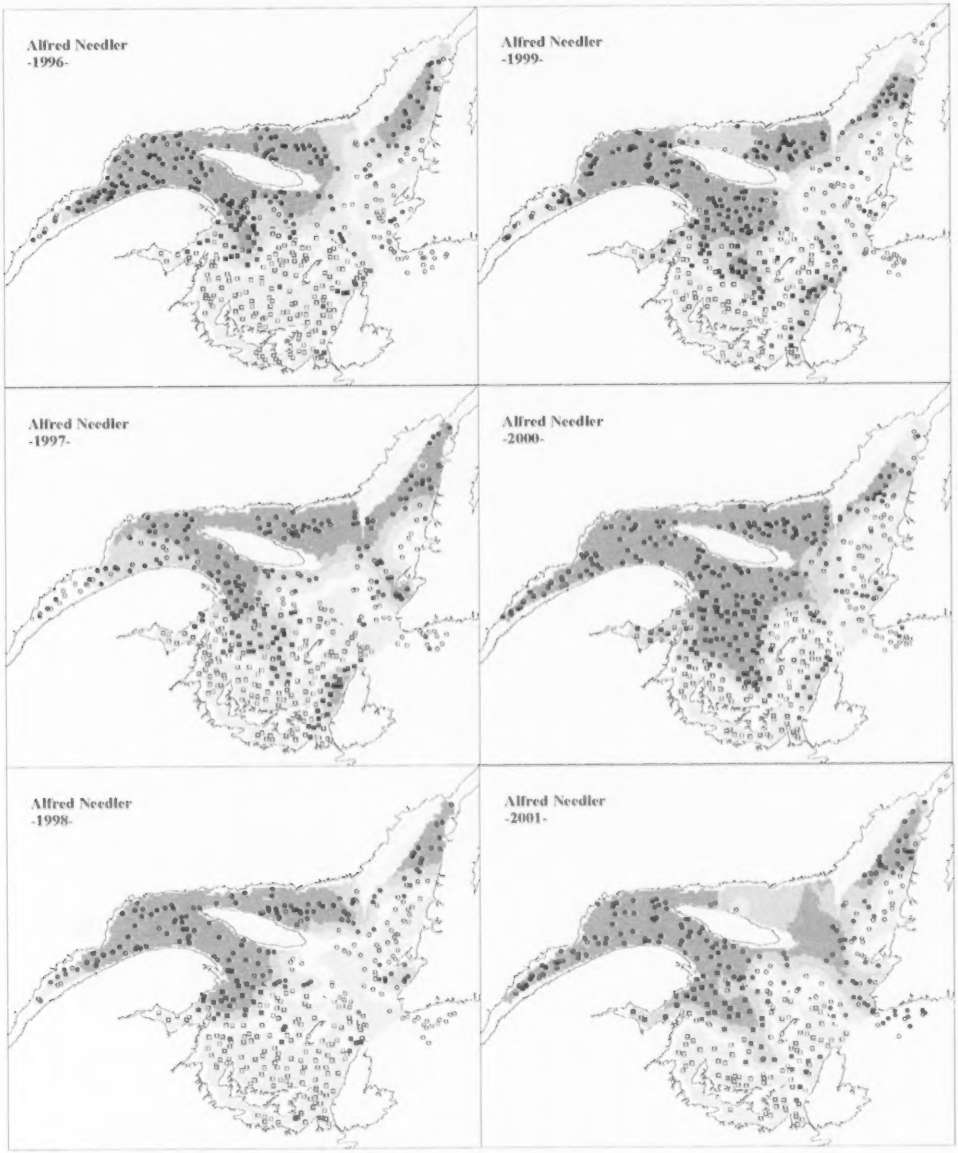
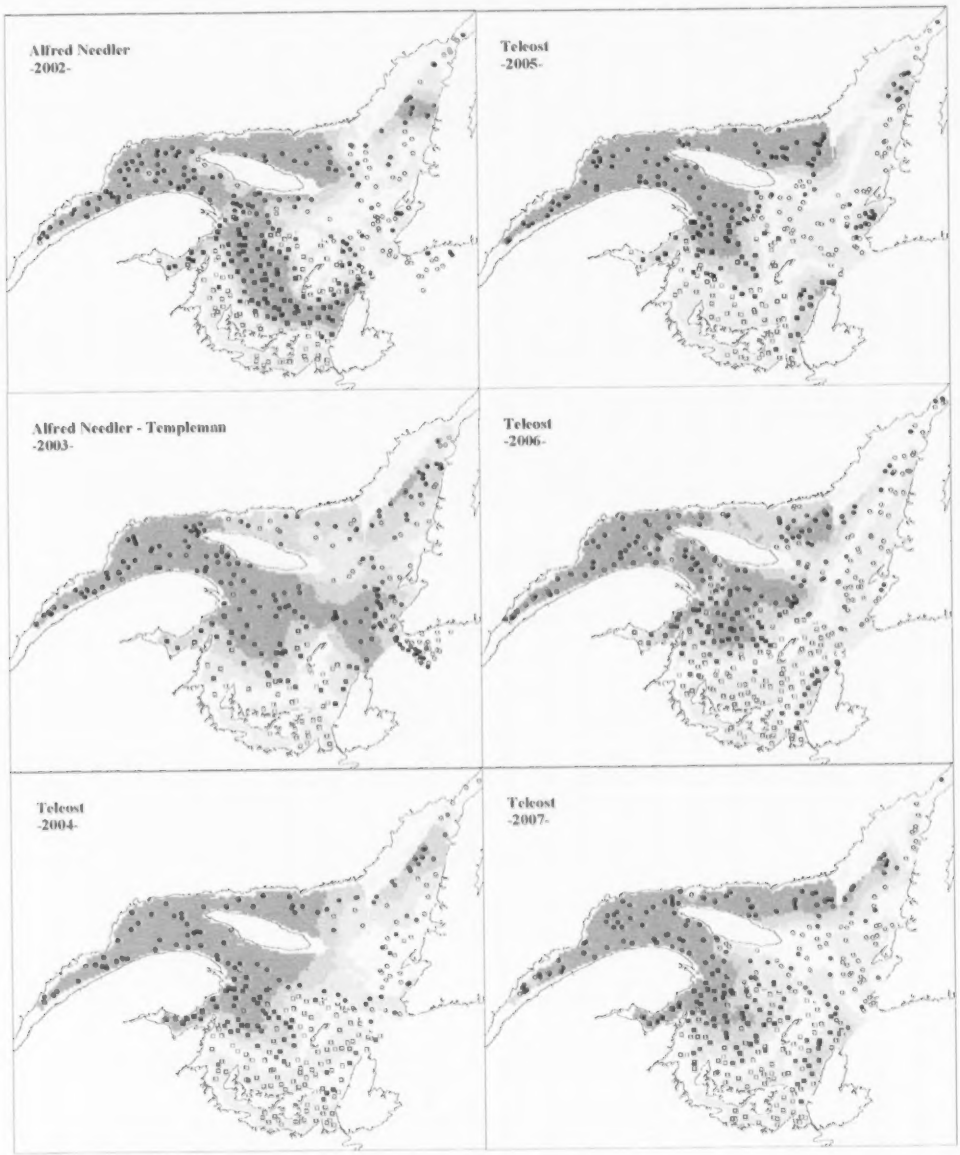


Figure 25. (Continued).



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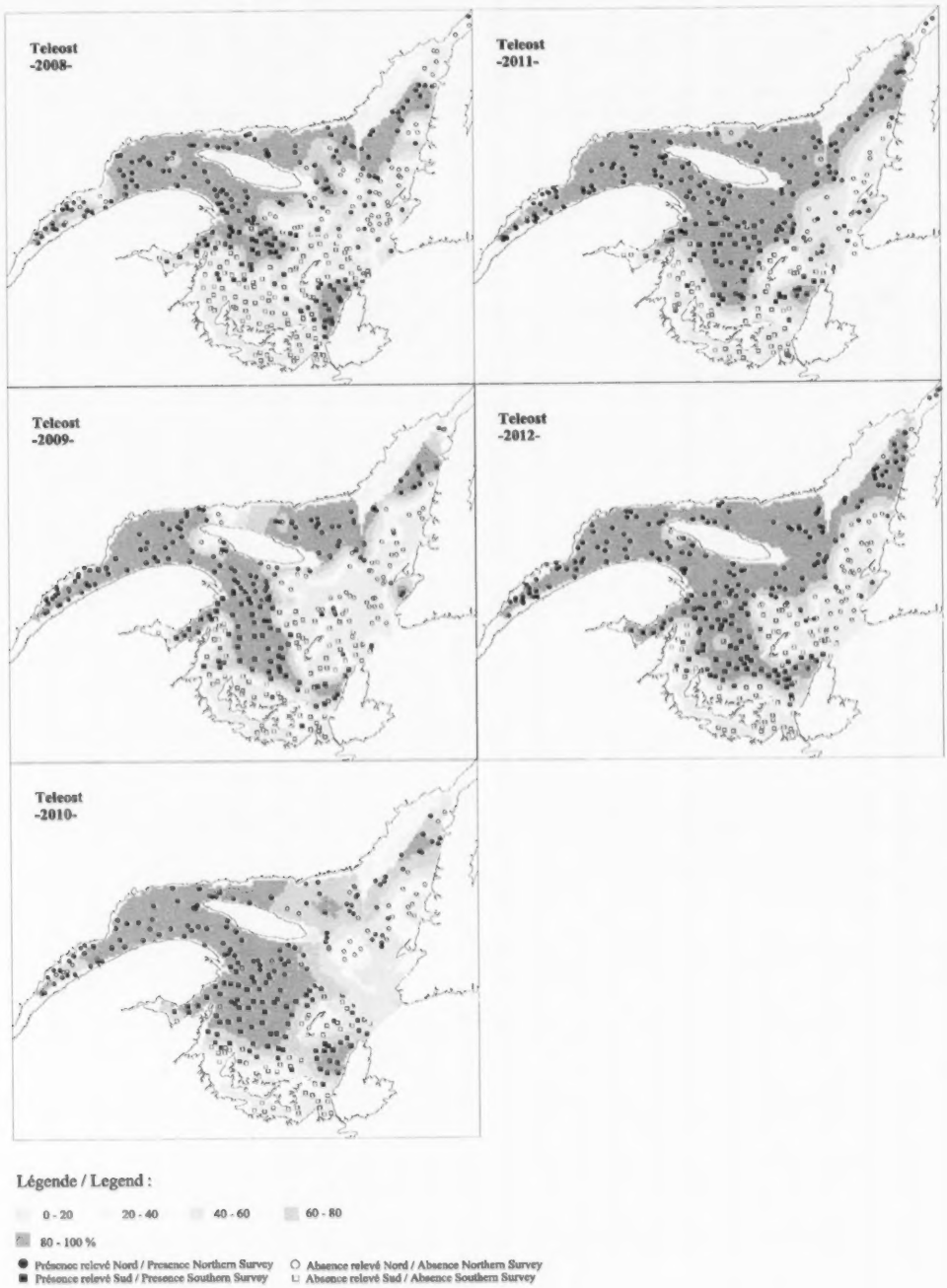

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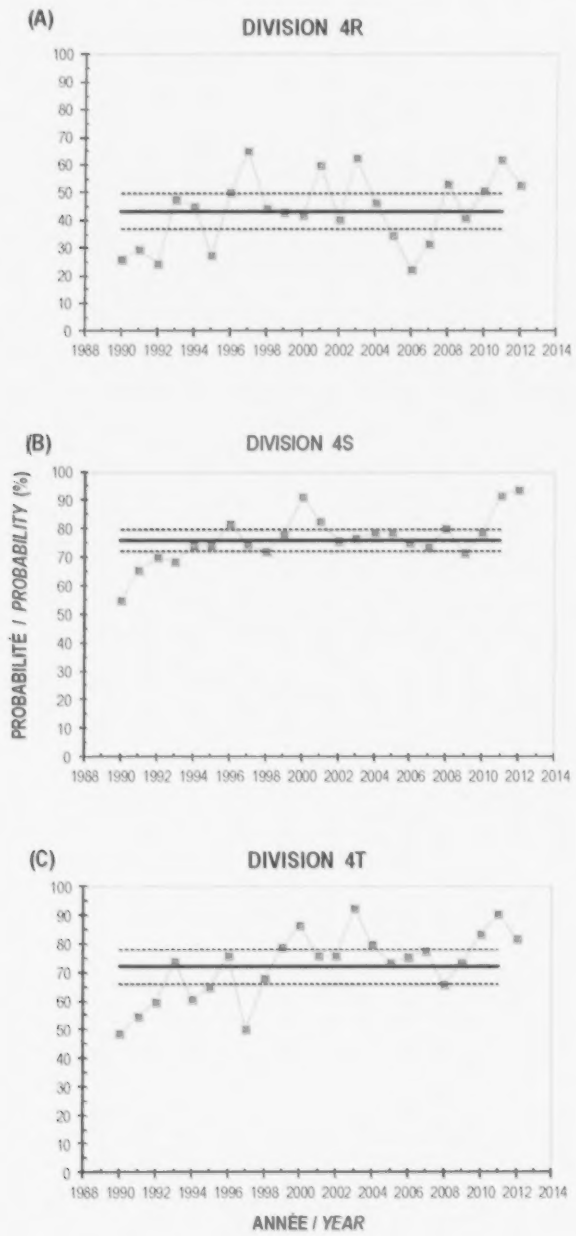


Figure 26. Mean capelin occurrence probabilities (%) in the NAFO divisions sampled by the Estuary, the northern, and the southern Gulf of St. Lawrence multidisciplinary surveys: (A) 4R-northern survey, (B) 4S-northern survey, (C) 4T-northern survey, and (D) 4RST-northern survey. The horizontal lines indicate the averages of the 1990-2011 period ± 0.5 x standard deviations.

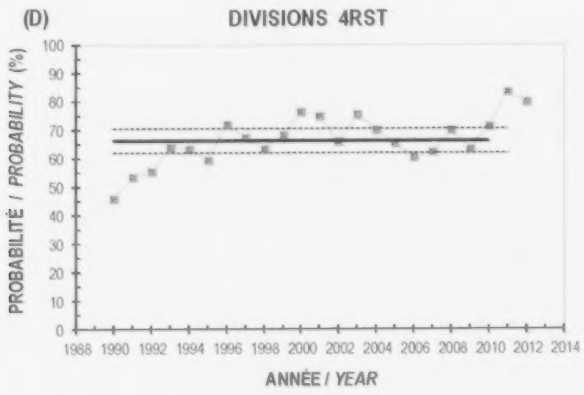


Figure 26. (Continued).

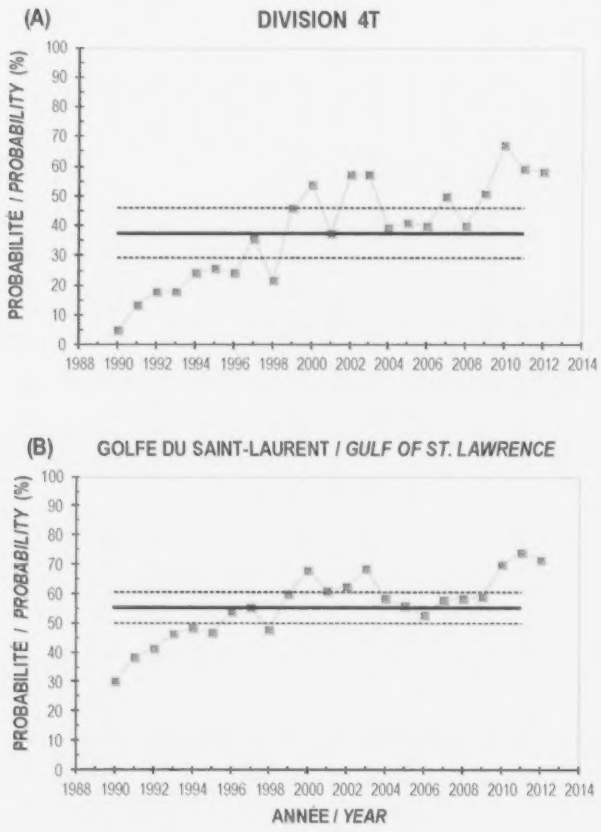


Figure 27. Mean capelin occurrence probabilities (%) in the divisions sampled by the Estuary, the northern, and the southern Gulf of St. Lawrence multidisciplinary surveys: (A) 4T-southern survey and (B) 4RST-both surveys. The horizontal lines indicate the averages of the 1990-2011 period ± 0.5 x standard deviations.

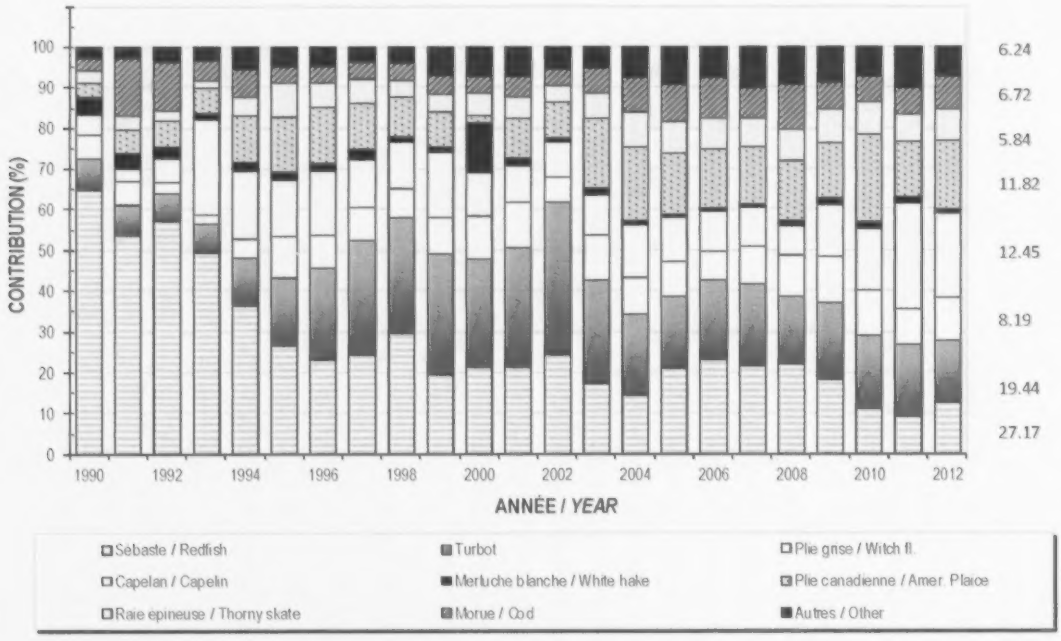


Figure 28. *Contributions (%) of the species that have characterized the multidisciplinary groundfish and shrimp surveys conducted in the Estuary and northern Gulf of St. Lawrence, from 1990 to 2012 (overall mean contributions in percentage are also presented).*

APPENDICES

Appendix 1. Terms of reference for the science advisory process for the capelin stock of the Estuary and Gulf of St. Lawrence.

Context

In the Estuary and Gulf of St. Lawrence. capelin has traditionally been used as fertilizer. bait or for its oil. Towards the end of the 1970s. the emergence of a Japanese market for roe-bearing females sparked a rapid growth of the fishery with catches that increased from approximately 700 t per year to nearly 10.000 t. In NAFO Divisions 4RST. most catches are made on the west coast of Newfoundland by a fleet of small and large purse seiners and by trap fishermen. Capelin is also caught using traps on Quebec's Lower North Shore and weirs in the St. Lawrence Estuary. In addition to recreational catches made on beaches during the spawning season. capelin are also a by-catch of the shrimp (*Pandalus borealis*) fishery and the groundfish and shrimp multidisciplinary surveys conducted annually in the Estuary and northern and southern Gulf of St. Lawrence.

Even though capelin population structures in the Estuary and Gulf of St. Lawrence are not clearly defined. the species is managed according to two distinct management units. NAFO Divisions 4R and 4ST. A Total Allowable Catch (TAC) of 11.195 t is applied to Division 4R compared with 1.805 t for all of Divisions 4ST. There is no abundance survey specifically directed on capelin. Consequently. it is impossible to calculate spawning biomass. fishing mortality and limit reference points. which would help define. based on the precautionary approach. a strategic framework for the fishery and a TAC.

The last capelin assessment in Divisions 4RST was conducted in 2011. The Fisheries Management Branch requested science advice on this stock for the 2013 and 2014 fishing seasons.

Objectives

Provide scientific advice on the capelin status in the Gulf of St. Lawrence (Divisions 4RST) to adjust the modalities of the fishery management for the 2013 and 2014 fishing seasons. This review will include:

- An assessment of the distribution of capelin based on:
    - An analysis of the commercial fishery statistics following the 2011 and 2012 fishing seasons (overall distribution of landings and breakdown by division. unit area. month and fishing gear);
    - Calculation of a performance index for the purse seine fishery;
    - An analysis of the biological data collected by port samplers or by observers (size structure and some biological parameters);
    - Calculation of the capelin by-catches by NAFO unit area in the Gulf of St. Lawrence shrimp fishery;

- Data from the CCGS Teleost research surveys conducted in the northern and southern Gulf of St. Lawrence (dispersion and distribution indices);

- Specific advices relying on the availability of recent and relevant data that can improve the responsible management of stock such as:

  - The presentation of the results and highlights of the genetic study on the northwest Atlantic stock differentiation;

- The identification and prioritization of research projects to be considered for the future.

- Recommendations on acceptable harvest levels for the 2013 and 2014 seasons.

Expected publications

- A Canadian Science Advisory Secretariat (CSAS) Science Advisory Report on capelin (4RST).

- CSAS Proceedings summarizing the discussions.

- CSAS research document.

Participation

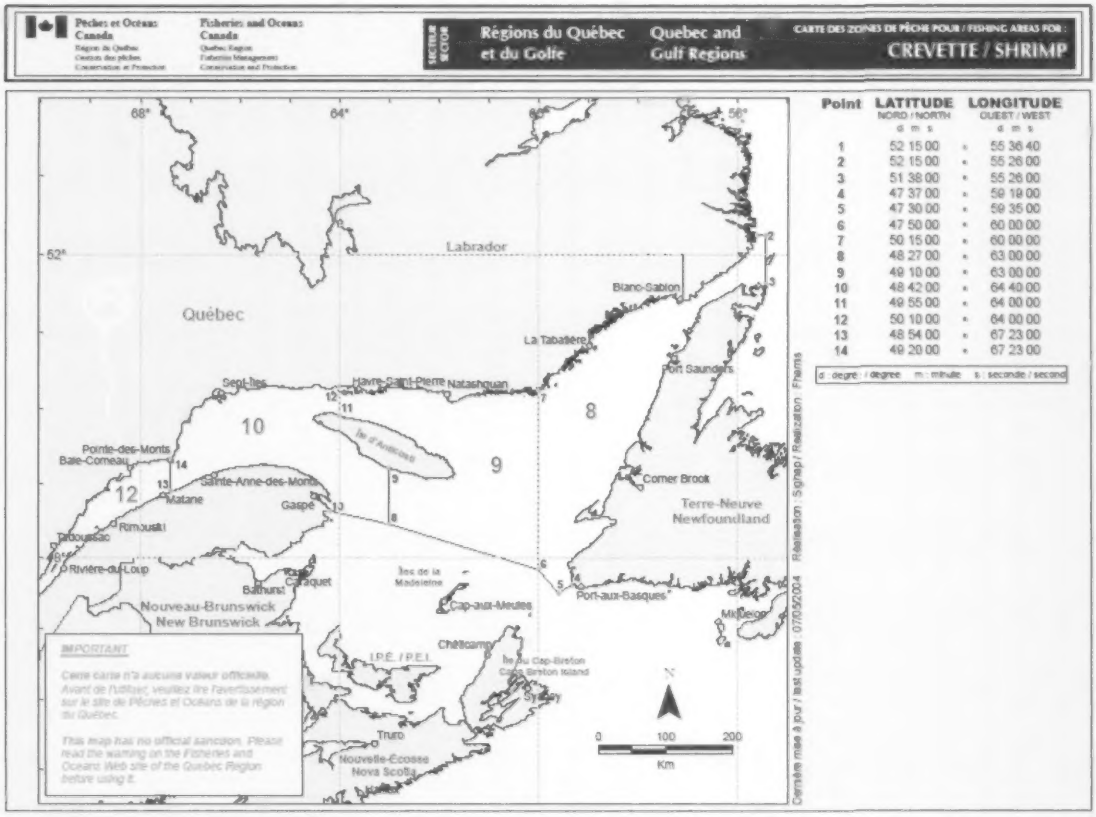
- Fisheries and Oceans Canada (DFO) Science and Fisheries Management Branches

- Fishing industry

- Provincial representatives

- Aboriginal communities/organizations

Appendix 2. Shrimp fishery areas in the Estuary and Gulf of St. Lawrence.*


Pêches et Océans Canada
Fisheries and Oceans Canada
SECTEUR / SECTOR
Régions du Québec et du Golfe
Quebec and Gulf Regions
CARTE DES ZONES DE PÊCHE POUR / FISHING AREAS FOR :
CREVETTE / SHRIMP
Point LATITUDE NORD / NORTH d m s LONGITUDE OUEST / WEST d m s
1 52 15 00 55 36 40
2 52 15 00 55 26 00
3 51 38 00 55 26 00
4 47 37 00 59 19 00
5 47 30 00 59 35 00
6 47 50 00 60 00 00
7 50 15 00 60 00 00
8 48 27 00 63 00 00
9 49 10 00 63 00 00
10 48 42 00 64 40 00
11 49 55 00 64 00 00
12 50 10 00 64 00 00
13 48 54 00 67 23 00
14 49 20 00 67 23 00
d : degré / degree m : minute s : seconde / second
Québec
Labrador
Blanc-Sablon
La Tabatière
Port Saunders
Sept-Îles
Havre-Saint-Pierre
Natashquan
Pointe-des-Monts
Baie-Comeau
Sainte-Anne-des-Monts
Matane
Gaspé
Rimouski
Tadoussac
Rivière-du-Loup
Bathurst
Caraquet
Nouveau-Brunswick
New Brunswick
Îles de la Madeleine
Cap-aux-Meules
Port-aux-Basques
Corner Brook
Terre-Neuve
Newfoundland
Miscou
Chéticamp
Île du Cap-Breton
Cape Breton Island
IPÉ / PEI
Truro
Nouvelle-Écosse
Nova Scotia
IMPORTANT
Cette carte n'a aucune valeur officielle. Avant de l'utiliser, veuillez lire l'avertissement sur le site de Pêches et Océans de la région du Québec.
This map has no official sanction. Please read the warning on the Fisheries and Oceans Web site of the Quebec Region before using it.
N
0 100 200
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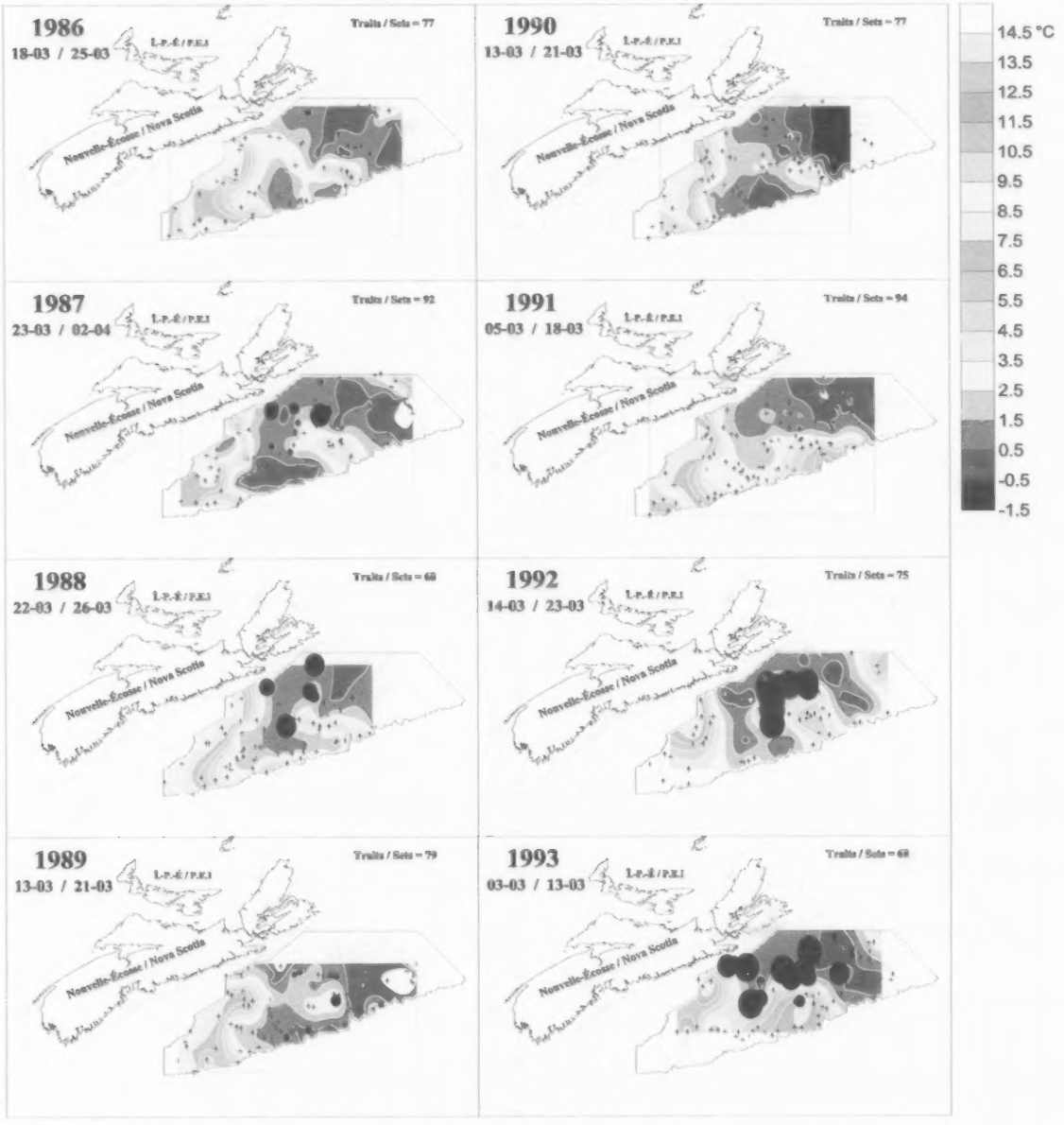
Dernière mise à jour / last update : 07/05/2004 Réalisation Sgrap / Realization Pharris

* 8-Esquiman. 9-Anticosti. 10-Sept-Îles. 12-*Estuary*

Appendix 3. List of the main fish species caught by the multidisciplinary surveys in the northern Gulf of St. Lawrence.

SPECIES	COMMON NAME
Melanogrammus aeglefinus	Haddock
Squalus acanthias	Spiny dogfish
Centroscyllium fabricii	Black dogfish
Mallotus villosus	Capelin
Hippoglossus hippoglossus	Atlantic halibut
Pollachius virens	Pollock
Clupea harengus	Herring
Ammodytes sp.	Sandlances
Limanda ferruginea	Yellowtail flounder
Merluccius bilinearis	Silver hake
Urophysis tenuis	White hake
Urophysis chesteri	Long-finned hake
Gadus morhua	Cod
Hippoglossoides platessoides	American plaice
Glyptocephalus cynoglossus	Witch plaice
Amblyraja radiata	Thorny skate
Malacoraja senta	Smooth skate
Leuroraja ocellata	Winter skate
Sebastes spp.	Redfish
Reinhardtius hippoglossoides	Turbot (Greenland halibut)

Appendix 4. *Capelin catches (n/set) and bottom water temperatures (°C) for the DFO groundfish multidisciplinary surveys conducted during the winter on the Scotia Shelf, from 1986 to 2010 (source of data: Virtual Data Center, DFO, Bedford Institute of Oceanography, Nova Scotia).*



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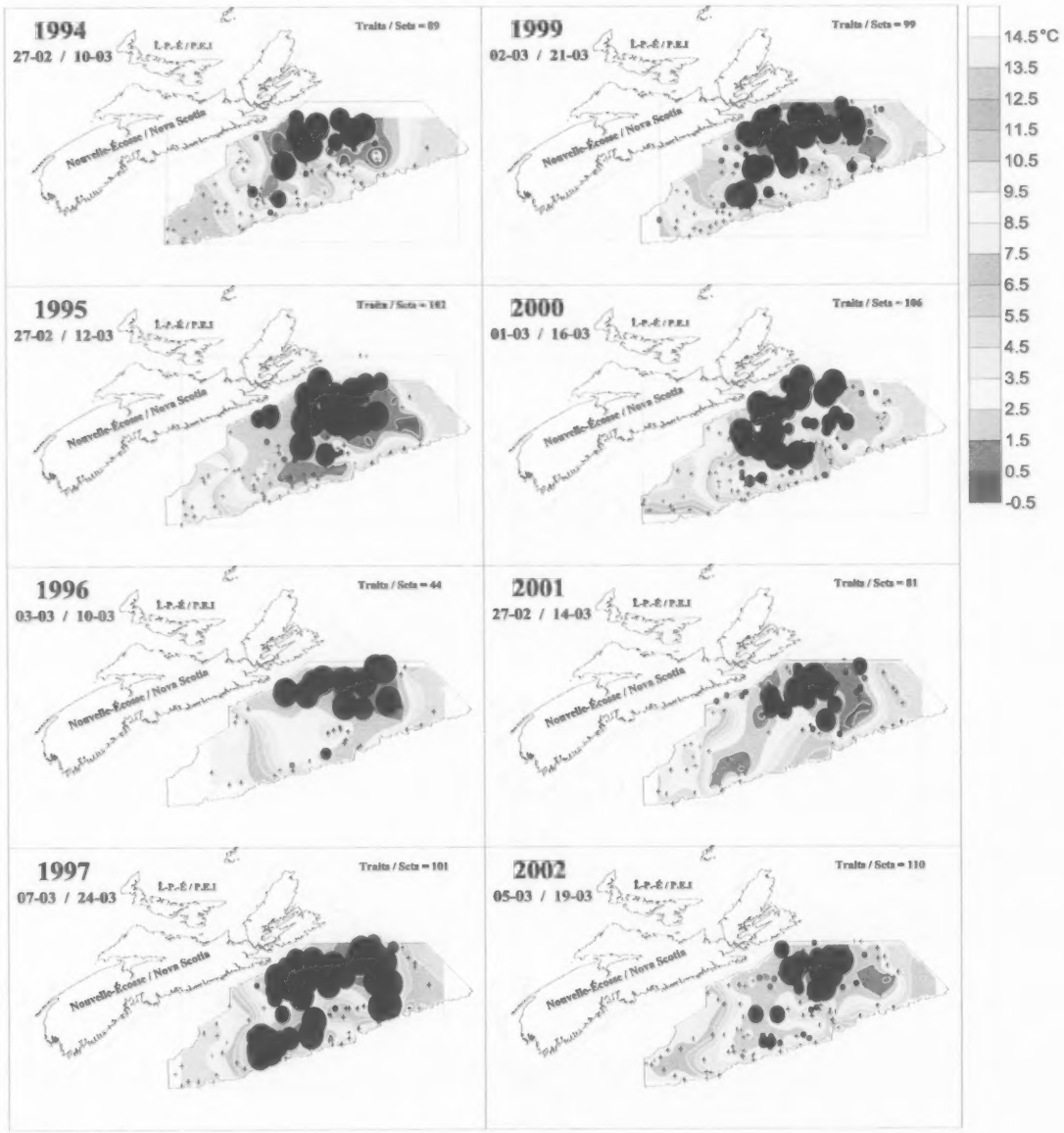
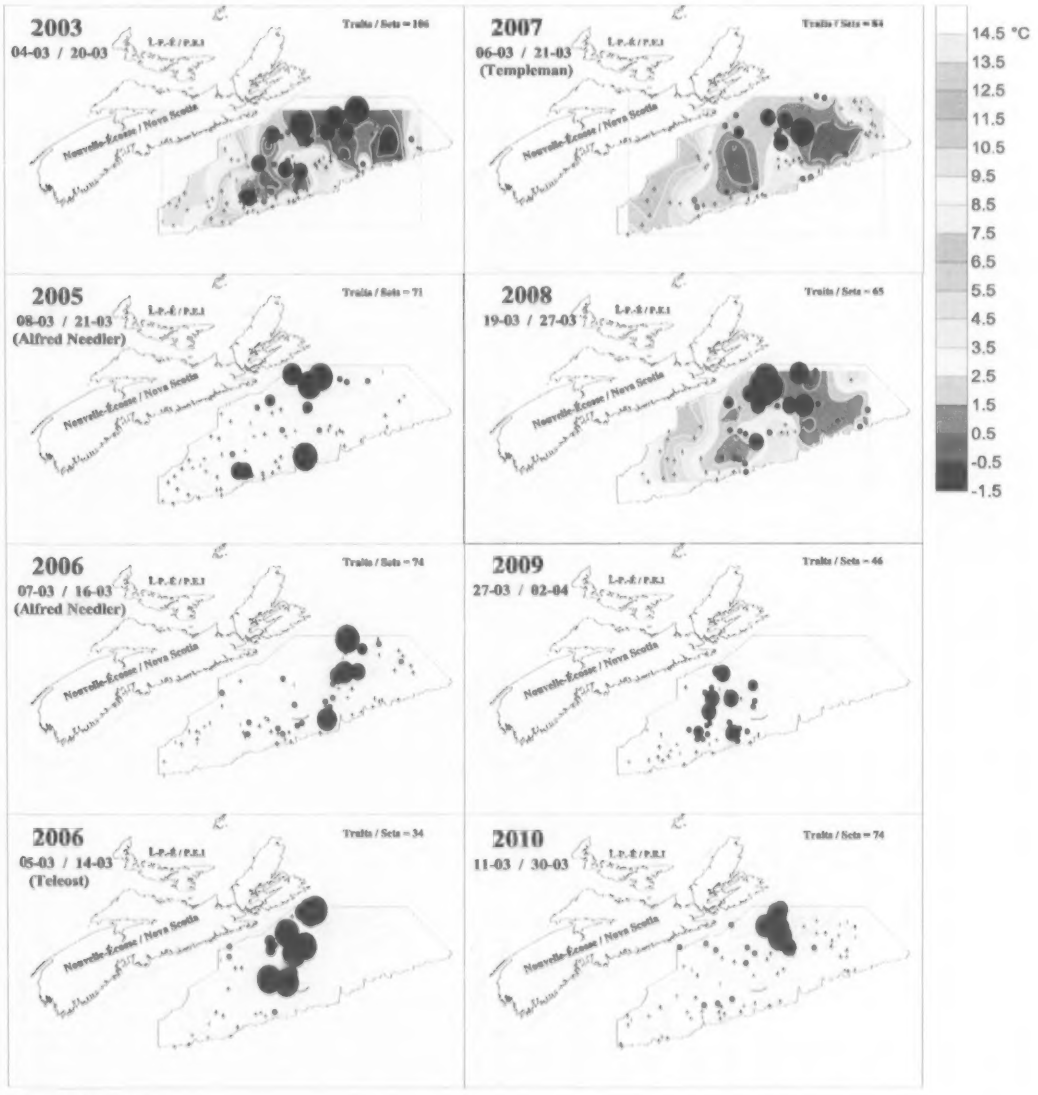


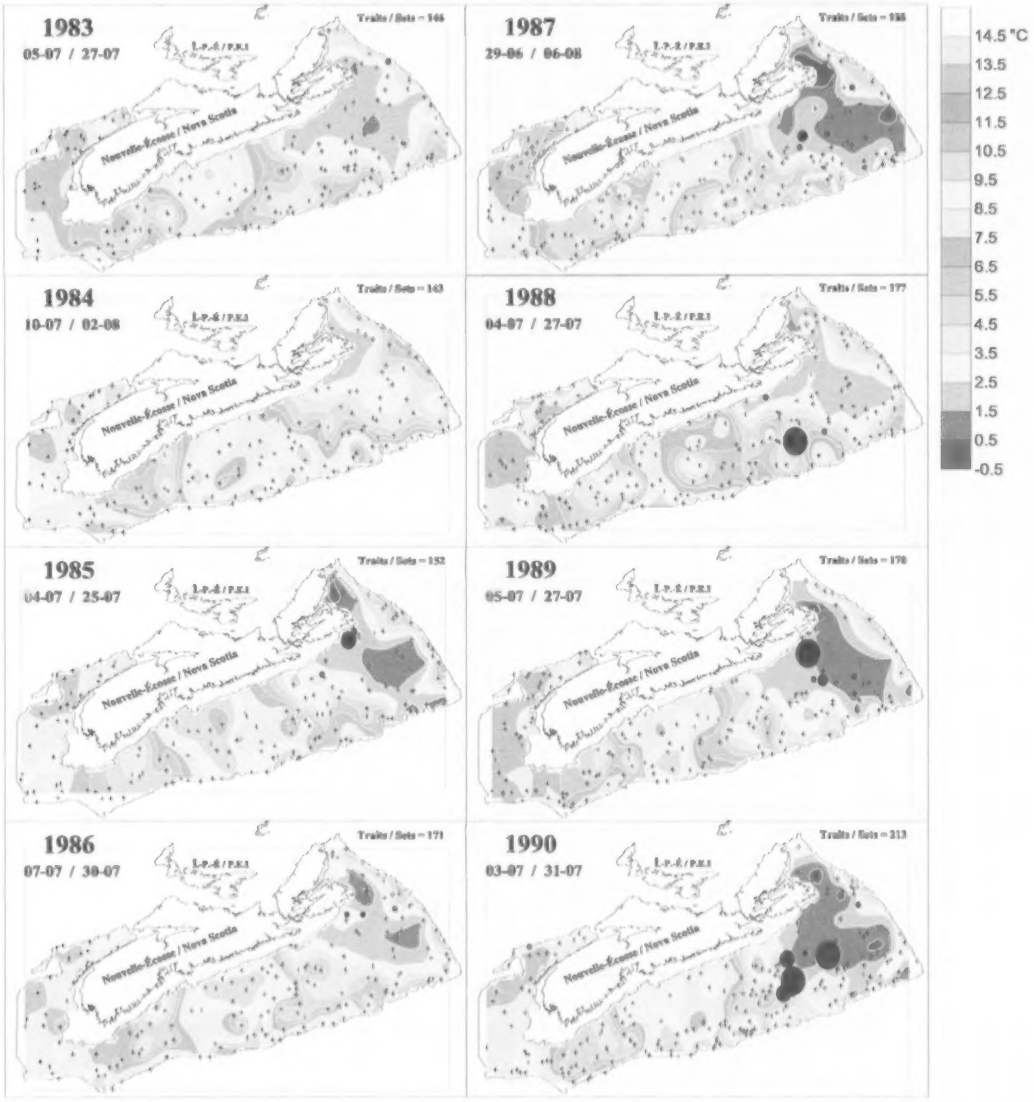
Légende / Lengend :

- 0
- 1-10
- 10-20
- 20-50
- 50-100
- > 100 nb/trait-set

Appendix 4. (Continued).



Appendix 5. Capelin catches (n/set) and bottom water temperatures (°C) for the DFO groundfish multidisciplinary surveys conducted during the summer on the Scotian Shelf, from 1983 to 2012 (source of data: Virtual Data Center, DFO, Bedford Institute of Oceanography, Nova Scotia).



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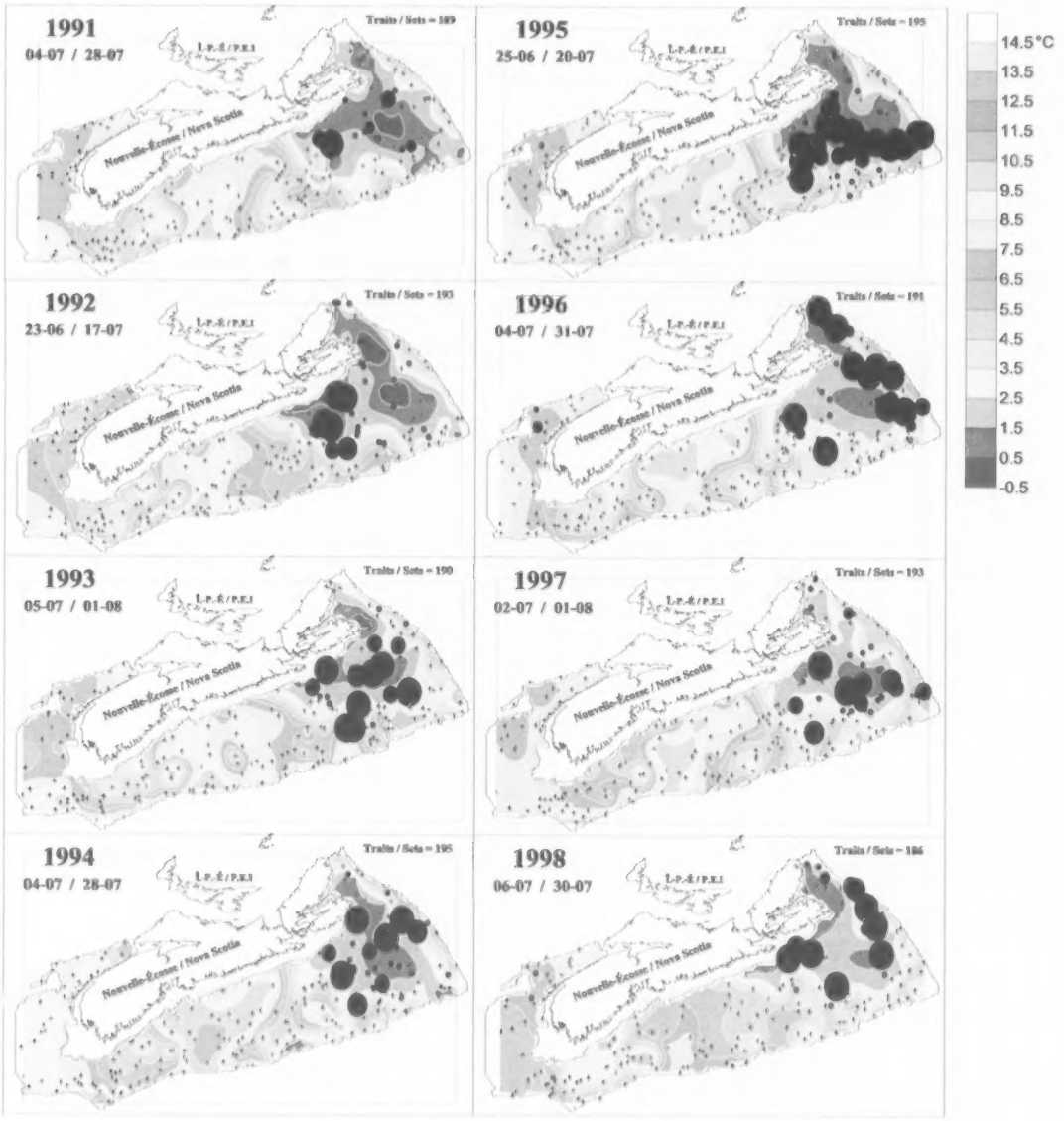

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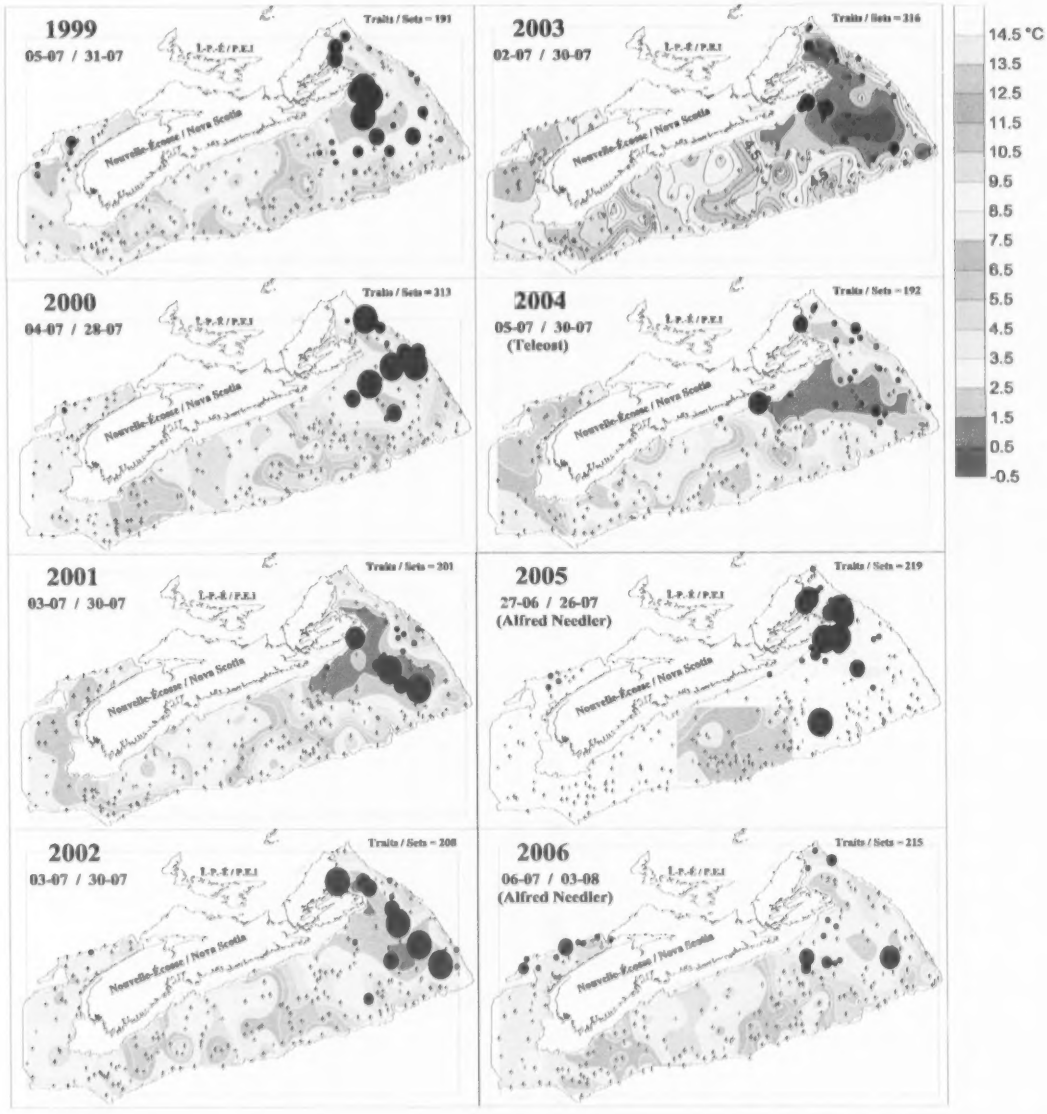

Légende / Lengend :

- 0
- 1-10
- 10-20
- 20-50
- 50-100
- > 100 nb/trait-set

Appendix 5. (Continued).